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Tank Characterization Report for Single-Shell Tank 241-C-104

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U.S. Department of Energy Contract DE-AC06-87RL10930

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Abstract: This document summarizes the information on the historical uses, present status, and the sampling and analysis results of waste stored in Tank 241-C-104. This report supports the requirements of the Tri-Party Agreement Milestone M-44-10.

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Tank Characterization Report for Single-Shell Tank 241-C-104

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LIST OF TERMS

AEA	alpha energy analysis
ANOVA	analysis of variance
AT	total alpha activity
BNW	Battelle Northwest Laboratory waste
Btu/hr	British thermal units per hour
cal/g	calories per gram
Ci	curies
Ci/L	curies per liter
cm	centimeter
c/s	counts per second
CW	aluminum cladding waste
CWP	PUREX cladding waste
CWP1	PUREX cladding waste (1952-1960)
CWP2	PUREX cladding waste (1961-1972)
CWP/Zr	PUREX zirconium cladding waste
CWR1	cladding waste from REDOX plant (1952-1960)
CWR2	cladding waste from REDOX plant (1961-1972)
df	degrees of freedom
DQO	data quality objectives
DSC	differential scanning calorimetry
DW	decontamination waste
ECN	engineering change notice
FIC	Food Instrument Corporation
ft	feet
g	gram
gal/MTU	gallons per metric ton uranium
g/cm^3	grams per cubic centimeter
GEA	gamma energy analysis
g/L	grams per liter
g/mL	grams per milliliter
HDW	Hanford defined waste
HS	strontium semiworks waste
HTCE	historical tank content estimate
IC	ion chromatography
ICP	inductively coupled plasma spectroscopy
in.	inch
IX	ion exchange waste

LIST OF TERMS (Continued)

J/g	joules per gram
kg	kilogram
kgal	kilogallon
kL	kiloliter
kw	kilowatt
LANL	Los Alamos National Laboratory
LFL	lower flammability limit
LL	lower limit
m	meter
M	moles per liter
mg/L	milligrams per liter
mg/m^3	milligrams per cubic meter
mL	milliliter
mm	millimeter
MT	metric tons
MTU	metric tons uranium
MW	metal waste
N	N-Reactor
n/a	not applicable
N/A	not available
NA	not analyzed
n/r	not reported
N/R	not reviewed
OWW3	organic wash waste from PUREX process (1968-1972)
P	PUREX high-level waste
P2	PUREX waste (1968-1972)
PHMC	Project Hanford Management Contractor
PL	PUREX low-level waste
PNNL	Pacific Northwest National Laboratory
ppbv	parts per billion volume
ppm	parts per million
ppmv	parts per million volume
PUREX	plutonium-uranium extraction
QC	quality control
R	REDOX high-level waste
R1	REDOX concentrated waste (1952-1957)
REDOX	reduction-oxidation
REML	restricted maximum likelihood estimation
RPD	relative percent difference
SACS	surveillance analysis computer systems
SAP	safety analysis plan
Si/MTU	silicon per metric ton uranium

LIST OF TERMS (Continued)

SL	sludge
SMM	supernatant mixing model
SMMA1	saltcake waste (1970 -1980, A-102 feed)
SRR	strontium recovery sludge
SU	supernatant
SWLIQ	dilute, non-complexed waste from 200-East Area single-shell tanks
TBP	tributyl phosphate (uranium recovery) waste
TCP	tank characterization plan
TCR	tank characterization report
TGA	thermogravimetric analysis
TH	thoria high-level waste
THL	thoria low-level waste
TIC	total inorganic carbon
TLM	tank layer model
TOC	total organic carbon
TSAP	tank sampling and analysis plan
TWRS	Tank Waste Remediation System
UL	upper limit
UR	uranium recovery
VSS	vapor sampling system
W	watts
WHC	Westinghouse Hanford Company
WSTRS	waste status and transaction record summary
wt%	weight percent
°C	degrees Centigrade
°F	degrees Fahrenheit
μCi/g	microcuries per gram
μCi/L	microcuries per liter
μCi/mL	microcuries per milliliter
μeq/g	microequivalents per gram
μg	microgram
μg/g	micrograms per gram

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1.0 INTRODUCTION

A major function of the Tank Waste Remediation System (TWRS) is to characterize wastes in support of waste management and disposal activities at the Hanford Site. Analytical data from sampling and analysis, along with other available information about a tank, are compiled and maintained in a tank characterization report (TCR). This report and its appendices serve as the TCR for single-shell tank 241-C-104.

The objectives of this report are: 1) to use characterization data in response to technical issues associated with tank 241-C-104 waste; and 2) to provide a standard characterization of this waste in terms of a best-basis inventory estimate. The response to technical issues is summarized in Section 2.0, and the best-basis inventory estimate is presented in Section 3.0. Recommendations regarding safety status and additional sampling needs are provided in Section 4.0. Supporting data and information are contained in the appendices. This report supports the requirements of the *Hanford Federal Facility Agreement and Consent Order* (Ecology et al. 1996) milestone M-44-10.

1.1 SCOPE

Characterization information presented in this report originated from sample analyses and known historical sources. While only the results of recent sample events will be used to fulfill the requirements of the data quality objectives (DQOs), other information can be used to support (or question) conclusions derived from these results. Historical information for tank 241-C-104, provided in Appendix A, included surveillance information, records pertaining to waste transfers and tank operations, and expected tank contents derived from a process knowledge model.

The recent sampling events listed in Table 1-1, as well as sample data obtained prior to 1989, are summarized in Appendix B along with the sampling results. The results of the 1996 sampling events, also reported in the laboratory data package (Fritts 1996), satisfied the data requirements specified in the tank characterization plan (TCP) for this tank (Baldwin and Winkelman 1996). The statistical analysis and numerical manipulation of data used in issue resolution are reported in Appendix C. Appendix D contains the evaluation to establish the best basis for the inventory estimate and the statistical analysis performed for this evaluation. A bibliography that resulted from an in-depth literature search of all known information sources applicable to tank 241-C-104 and its respective waste types is contained in Appendix E. The reports listed in Appendix E may be found in the Lockheed Martin Hanford Company Tank Characterization Resource Center.

Table 1-1. Summary of Recent Sampling.

Sample/date	Phase	Location	Segmentation	Percent Recovery
Vapor sample (2/17/94 and 3/3/94)	Gas	Tank headspace riser 2	n/a	n/a
Push mode sampling (7/29/96) Core 162	Solid Liquid	Riser 3	4 Segments Recovered only in segments 3 and 4	Segment recovery varied from 76 to 97 percent. NA
Push mode sampling (7/30-31/96) Core 165	Solid	Riser 14	6 segments	Segment recovery varied from 35 to 100 percent.

Notes:
n/a = not applicable
NA = not analyzed

Dates are in the mm/dd/yy format.

1.2 TANK BACKGROUND

Tank 241-C-104 is located in the 200 East Area C Tank Farm on the Hanford Site. It is the first tank in a three-tank cascade series consisting of tanks 241-C-104, C-105, and C-106. The tank first received metal waste from B Plant in the fourth quarter of 1946. The tank began to cascade waste to 241-C-105 during the first quarter of 1947. Tank 241-C-104 continued to receive metal waste until the fourth quarter of 1947 when the tank and cascade series were full. The tank remained full until the second quarter of 1953 when water was added and waste was sent to tank 241-C-106. The tank was sluiced and the waste was sent to U Plant for uranium recovery during the third and fourth quarters of 1953. Water was added to the tank during the first, second, and fourth quarters of 1954. Metal waste slurry was sent to U Plant for uranium recovery during the third quarter of 1954 and the first quarter of 1955. The tank was empty until the fourth quarter of 1955 when it received tributyl phosphate supernatant and metal waste from tank 241-C-112.

The tank received cladding waste from PUREX from the first quarter of 1956 to the second quarter of 1957. Waste was sent to tanks 241-C-101 and C-105 in the first and third quarters of 1956, respectively. Supernatant was cascaded to tank 241-C-105 during the second quarter of 1957.

The tank received supernatant from tank 241-C-105 in the first quarter of 1960. It received waste from the 244-CR Vault in the second quarter of 1965. Waste was sent to tank 241-C-102 during the second quarter of 1969. The tank received cladding waste and organic wash waste from PUREX from the fourth quarter of 1969 to the third quarter of 1972. During this time waste was sent to and received from various other tanks.

The tank received thoria waste in the third and fourth quarters of 1970. Also in the fourth quarter of 1970, the tank received PUREX low-level waste and waste from the 244-CR Vault.

In the fourth quarter of 1972, the tank received organic wash waste from PUREX. From the fourth quarter of 1972 to the first quarter of 1976, waste was sent to and received from various tanks.

Low-level waste was sent from PUREX to tank 241-C-104 in the first and second quarters of 1973; the second, third, and fourth quarters of 1974; the first, third, and fourth quarters of 1975; and the first and second quarters of 1976. High-level waste was sent from PUREX to tank 241-C-104 during the fourth quarter of 1973, the first quarter of 1974, and the second quarter of 1975. The tank received waste from the 244-CR Vault during the first quarter of 1974 and water during 1974 and 1975.

In the second quarter of 1976, waste was sent to and received from various tanks.

Tank 241-C-104 exchanged supernatant with tank 241-A-102 from 1976 to 1980. Supernatant was sent to tanks 241-AZ-101 and 241-AX-102 in 1978. During the third quarter of 1979, the tank received supernatant from tank 241-C-103. Salt well liquor was sent to tank 241-AW-105 in the third quarter of 1985.

A description of tank 241-C-104 is summarized in Table 1-2. The tank has an operating capacity of 2,010 kL (530 kgal), and presently contains an estimated 1,120 kL (295 kgal) of complexant concentrate waste (Hanlon 1997). The tank is not on the Watch List (Public Law 101-510).

Table 1-2. Description of Tank 241-C-104.

TANK DESCRIPTION	
Type	Single-shell
Constructed	1943 to 1944
In-service	October 1946
Diameter	22.9 m (75.0 ft)
Operating depth	5.2 m (17 ft)
Capacity	2,010 kL (530 kgal)
Bottom shape	Dish
Ventilation	Passive
TANK STATUS	
Waste classification	Complex
Total waste volume[1]	1,120 kL (295 kgal)
Supernatant volume	0 kL (0 kgal)
Saltcake volume	0 kL (0 kgal)
Sludge volume	1,120 kL (295 kgal)
Drainable interstitial liquid volume	42 kL (11 kgal)
Waste surface level (11/05/96)	219 cm (86.4 in.)[2]
Temperature (1/23/76 to 11/05/96)	12 °C (53 °F) to 90.6 °C (195 °F).
Integrity	Sound
Watch List	None
SAMPLING DATE	
Vapor sample	March 1994
Push mode samples	July 1996
SERVICE STATUS	
Declared inactive	1980
Interim stabilization	1989
Intrusion prevention	1990

Notes:

Dates are in mm/dd/yy format.

[1]Waste volume is estimated from surface level measurements.

[2]295 kgal equates to a waste depth of 291.3 cm (114.7 in.) at the tank centerline. The measured waste level was 219 cm (86.4 in.), possibly due to an uneven surface.

2.0 RESPONSE TO TECHNICAL ISSUES

Four technical issues have been identified for tank 241-C-104. They are:

Safety screening:

- Does the waste pose or contribute to any recognized potential safety problems?

Organic safety issue:

- Does the waste contain organics in concentrations that can support a propagating chemical reaction?

Hazardous vapor safety screening:

- Does the vapor headspace exceed 25 percent of the lower flammability limit (LFL)? If so, what are the principal fuel components?
- Are compounds of technological significance present in the tank at such a level that the industrial hygiene group shall be alerted to their presence so adequate breathing zone monitoring can be accomplished and future activities in and around the tank can be performed in a safe manner?

Organic solvents:

- Does an organic solvent pool exist that may cause an organic solvent pool fire or ignition of organic solvents entrained in waste solids?

The TCP (Baldwin and Winkelman 1996) provides the types of sampling and analysis used to address the above issues. Data from the recent analysis of two push mode samples and tank headspace flammability measurements provided the means to respond to these four issues. This response is detailed in the following sections. See Appendix B for sample and analysis data for tank 241-C-104.

2.1 SAFETY SCREENING AND ORGANIC DQO

The data needed to screen the waste in tank 241-C-104 for potential safety problems are documented in *Tank Safety Screening Data Quality Objective* (Dukelow et al. 1995). These potential safety problems are exothermic conditions in the waste; flammable gases in the waste and/or tank headspace; and criticality conditions in the waste.

The safety screening DQO was not the only safety-related DQO associated with the sampling effort. Tank 241-C-104 is not on the Organic Watch List, however reviews of waste transfer records indicate the possibility it has received substantial amounts of organic complexant material. The data needed to determine if the waste in tank 241-C-104 poses a potential safety concern with respect to a fuel (organic compounds) and oxidizer (nitrate or nitrite) propagating reaction are documented in *Data Quality Objective to Support Resolution of the Organic Complexant Safety Issue* (Turner et al. 1995).

2.1.1 Exothermic Conditions (Energetics)

The first requirement outlined in the safety screening DQO (Dukelow et al. 1995) is to ensure that there is not sufficient fuel in tank 241-C-104 to pose a safety hazard. Because of this requirement, energetics in the tank 241-C-104 waste were evaluated. The safety screening DQO required that the waste sample profile be tested for energetics every 24 cm (9.5 in.) to determine if the energetics exceed the safety threshold limit. The threshold limit for energetics is 480 J/g on a dry weight basis.

Results obtained using differential scanning calorimetry (DSC) indicated a low level of DSC activity with one sample (drainable liquid) exceeding the 95 percent confidence interval upper limit for DSC of 480 J/g on a dry weight basis. The percent water for this same sample (80%) indicates there is sufficient water to prevent a propagating reaction.

2.1.2 Flammable Gas

Vapor phase measurements, taken in the tank headspace prior to the push mode samples in July 1996, indicated that no flammable gas was detected (0 percent of the lower flammability limit). Data from these vapor phase measurements are presented in Appendix B.

2.1.3 Criticality

The safety threshold limit is 1 g ^{239}Pu per liter of waste. Based on the highest measured bulk density of 1.97 g/mL, 1 g/L of ^{239}Pu is equivalent to 31 μCi/g of alpha activity. $^{239/240}$Pu was measured directly for the segment having the highest total alpha. The $^{239/240}$Pu was 4.3 μCi/g, well below the threshold limit. There is no criticality concern for this tank.

2.1.4 Total Organic Carbon Content

Total organic carbon is a primary analyte for the organic DQO but not for the safety screening DQO. The total organic carbon (TOC) decision threshold is 3 percent TOC (dry weight). Eight samples from tank 241-C-104, submitted for TOC determination exceeded the one-sided 95 percent upper confidence limit of the mean notification limit of 3 percent TOC (dry weight). A review of the percent water for these same samples indicates there is sufficient water to prevent a propagating reaction. According to the organic DQO's decision rule, the tank could be declared "conditionally safe" with respect to organic content.

2.1.5 Moisture Content

Moisture content by thermogravimetric analysis (TGA) is another primary analyte for the organic DQO, but not for the safety screening DQO. The percent moisture decision threshold is ≤ 17 percent. These samples were below this threshold at the lower 95 percent confidence limit of the mean (Table C1-3). The DSC for these same samples was less than 480 J/g; therefore, the low percent moisture level is not a safety concern. The mean moisture level in the tank is 50 percent.

2.2 HISTORICAL EVALUATION

The purpose of the historical evaluation is to determine whether the model, based on process knowledge and historical information (Brevick et al. 1995; Agnew et al. 1996a), predicts tank inventories that are in agreement with current tank inventories. If the historical model can be shown to accurately predict the waste characteristics as observed through sample characterization, then there is a possibility that the amount of total sampling and analysis needed may be reduced. Data requirements for this evaluation are documented in *Historical Model Evaluation Data Requirements* (Simpson and McCain 1996).

Tank C-104 is considered a spatially complex tank. For spatially complex tanks, the historical DQO (Simpson and McCain 1996) requires the analysis of the solids composite of each core. The analyses are DSC, TGA, total inorganic carbon/total organic carbon (TIC/TOC), gamma energy analysis (GEA) (^{137}Cs), ion chromatography (IC) (all anions), total uranium, Sr-90 (beta counting), total beta and inductively coupled plasma spectroscopy (ICP) (all metals). A composite for each of the cores was made.

The subsegment level data from tank 241-C-104 suggest a vertically heterogeneous structure. The concentration behavior of aluminum, uranium, and zirconium as a function of depth implies a highly layered waste matrix. This condition was expected because of the relatively high level of transfer activity that occurred in this tank. Interpretation of the subsegment data is clouded by the asymmetrical distribution of waste in the tank. The trends observed hold true in both cases.

The top region of the tank, consisting of approximately 48 cm (19 in.), appears to be zirconium cladding waste, with some aluminum cladding waste mixed in. The mixture and concentrations of analytes in this material (aluminum at approximately 1 percent, nickel at about 1.5 percent, uranium and iron between 2 percent and 5 percent, and zirconium between about 1 percent and 8 percent) supports this interpretation.

The upper middle region of the tank, consisting of segments 2 and 3 in core 162 and segments 2 to 4 in core 165, does not appear to be a single waste type, but rather a mixture of several wastes, and appears to be laterally heterogenous. The aluminum concentration modestly increases, and uranium, iron, and nickel stay about the same. The zirconium concentration drops substantially below 1 percent in core 162 but maintains a concentration of about 9 percent in core 165, which also suggests lateral heterogeneity. Other analytes that were not present in substantial quantities in the previous segment are now present (manganese and silicon between 1 percent and 3 percent) in core 162, where they are not present in core 165.

The lower middle region of the tank, consisting of segment 5 in core 165 does not have a corresponding sample in core 162. Compositionally, this sample is much different from the others observed. Aluminum concentrations are modest, about 1 percent, and zirconium concentrations are even lower, about 0.2 percent to 0.3 percent in the upper subsegment. Zirconium concentration in the lower subsegment jumps to 5 percent. Iron and nickel vary significantly between the two subsegments (between 1 percent and 5 percent), and uranium is at about 1 percent.

The lower region of the tank, consisting of segment 4 in core 162 and most of segment 6 in core 165, changes composition abruptly. Aluminum concentrations go from between 3 to 5 percent to almost 20 percent. Iron and nickel concentrations fall to below 1 percent, and uranium remains about 1 percent. Zirconium concentrations drop below 0.5 percent. These analytes in the above described concentrations are suggestive of aluminum cladding waste.

The process history indicates that a small residual heel of metal waste may lie at the very bottom of this tank. The sampling data available to support that premise are very limited. The lowest subsegment from core 165 has a uranium concentration of about 3 percent, possibly indicating a transition layer from the cladding waste. That uranium concentration is not out of the range observed in some aluminum cladding waste samples, thus in this case the analytical evidence is inconclusive. The analytical results for the core composites are reported in Appendix B.

2.3 HAZARDOUS VAPOR SAFETY SCREENING

The data required to support vapor screening were documented in *Data Quality Objective for Tank Hazardous Vapor Safety Screening* (Osborne and Buckley 1995). Does the vapor headspace exceed 25 percent of the LFL? If so, what are the principal fuel components? Are compounds of technological significance present in the tank at such a level that the industrial hygiene group shall be alerted to their presence so adequate breathing zone monitoring can be accomplished and future activities in and around the tank can be performed in a safe manner?

2.3.1 Flammable Gas

This is the same requirement as the safety screening flammability requirements. The flammability issue is addressed in Section 2.1.2.

2.3.2 Toxicity

The vapor screening DQO requires the analysis of ammonia, carbon dioxide (CO_2), carbon monoxide (CO), nitric oxide (NO), nitrous oxide (N_2O), and nitrogen dioxide (NO_2) from a sample. The vapor screening DQO specifies a threshold limit for each of the above listed compounds. The vapor screening DQO did not exist at the time vapor sampling was conducted in tank 241-C-104; however, the compounds of concern were within specification. The toxicity issue has been closed for all tanks (Hewitt 1996).

2.4 ORGANIC SOLVENTS

The data required to support the organic solvent screening issue were documented in the 93-5 implementation plan. A new DQO is currently being developed to address the organic solvent issue. In the interim, tanks are to be sampled for total non-methane hydrocarbon to determine if an organic extractant pool greater than 1 m^2 (10.8 ft^2) exists (Cash 1996). The purpose of this assessment is to ensure that the organic solvent pool is sufficiently small to ensure that an organic solvent pool fire or ignition of organic solvents cannot occur. The size of the organic extract and pool will be determined by the organic program, based on vapor data, tank headspace temperature, and tank ventilation rate.

2.5 OTHER TECHNICAL ISSUES

A factor in assessing tank safety is the heat generation and temperature of the waste. Heat is generated in the tanks from radioactive decay. An estimate of the tank heat load based on the 1996 sample event was 4,881 W (16,671 Btu/hr). The heat load estimate based on the tank process history was 8,520 W (29,100 Btu/hr) (Agnew et al. 1996a). The heat load estimate based on the tank headspace temperature was 3,340 W (11,410 Btu/hr) (Kummerer 1994). All of these estimates are low, and are well below the limit of 11,700 W (40,000 Btu/hr) that separates high- and low-heat-load tanks (Smith 1986). The major contributors to the tank heat load are listed in Table 2-1. Radionuclides were chosen for the heat load calculation based on measurement above the detection limit and for contribution to the heat load greater than 0.001 W.

Table 2-1. Tank 241-C-104 Projected Heat Load.

		Liquid		Solid	
Radionuclide	Watts/Curie	Curies	Watts	Curies	Watts
^{241}Am	0.03	N/A	N/A	7.15E+03	234
^{137}Cs	0	N/A	N/A	1.20E+05	566
^{90}Sr	0	N/A	N/A	6.09E+05	4,080
Total watts					4,881

Note:
N/A = not available

2.6 SUMMARY

One sample (drainable liquid) exceeded the 95 percent confidence interval upper limit for DSC of 480 J/g on a dry weight basis. The percent water for this same sample indicates there is sufficient water to prevent a propagating reaction. According to the organic DQO's decision rule, the tank could be declared "conditionally safe." The analyses results are summarized in Table 2-2.

Table 2-2. Summary of Safety Screening and Historical Evaluation Results.

Issue	Sub-issue	Result
Safety screening	Energetics	One sample (drainable liquid) exceeded 480 J/g on a dry weight basis.
	Flammable gas	Vapor measurement reported 0 percent of lower flammability limit. (combustible gas meter).
	Criticality	The highest measured $^{239/240}Pu$ was 4.3 μCi/g well below the limit of 36 μCi/g for this tank.
Historical	Core composite analysis	Completed - data provided in Appendix B.
Organic	Energetics	See energetics issue for safety screening above.
	Organic content	Eight samples exceeded the one-sided 95% upper confidence limit of the mean notification limit of 3% TOC (dry weight). The percent water for these samples is sufficient to prevent a propagating reaction.
	Moisture	All weight percent water results were greater than 17 wt%
Vapor	Flammable gas	See flammable gas safety screening above.
	Toxicity[1] characterization	All compounds were within limits.

Note:

[1]The toxicity issue has been closed for all tanks (Hewitt 1996).

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3.0 BEST-BASIS STANDARD INVENTORY ESTIMATE

Information about the chemical and/or physical properties of tank wastes is used to perform safety analyses, engineering evaluations, risk assessments associated with waste management activities, and to address regulatory issues. Waste management activities include overseeing tank farm operations and identifying, monitoring, and resolving safety issues associated with these operations and with the tank wastes. Disposal activities involve designing equipment, processes, and facilities for retrieving wastes and processing the wastes into a form that is suitable for long-term storage. Chemical inventory information is derived using two approaches: 1) component inventories are estimated using the results of sample analyses; and 2) component inventories are predicted using a model based on process knowledge and historical information. The current model was developed by Los Alamos National Laboratory (LANL) (Agnew et al. 1996b). Information derived from these two different approaches is often inconsistent.

An effort is underway to provide waste inventory estimates that will serve as the standard characterization information for the various waste management activities. As part of this effort, evaluation of available chemical information for tank 241-C-104 was performed that included:

1. Data from three core samples taken in 1986 and 1996 (Weiss and Schull 1988) and the statistical analysis results from the 1996 sampling event for this tank (Appendix B).

2. Component inventory estimates provided by the Hanford defined waste (HDW) model (Agnew et al. 1996a).

3. Evaluation of CWP1[1] and CWP2[2] wastes based on the fuel and waste transaction records and fuel fabrication records.

4. Analysis of CWP1/CWP2 sludge based on common sludge layers in tank 241-C-105 and the waste transaction records for tanks 241-C-104 and 241-C-105.

5. Analysis of the PUREX flowsheet , thorium campaign records and the composition of OWW3[3] waste, together with the waste transaction records for tank 241-C-104.

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[1]PUREX cladding waste (1952-1960)

[2]PUREX cladding waste (1961-1972)

[3]Organic wash waste from PUREX process (1968-1972)

6. Analysis of residual metal waste based on the composition of tank 241-C-104 metal waste (MW).

7. Evaluation of the estimated thermal loads provided by the sample-based inventories of ^{90}Sr and ^{137}Cs relative to thermal modeling results for this tank. Based on this analysis, a best-basis inventory was developed. The 1996 cores (and for Al, Mn and PO_4, average values for the 1986 core and two 1996 cores) were used to generate estimates for the chemical and radionuclide components in this waste. The waste in tank 241-C-104 primarily consists of PUREX coating (CWP1 and CWP2) waste, PUREX zirconium cladding (CWP/Zr) waste, $BiPO_4$ MW, OWW3 waste, PUREX TH waste, PUREX high-level (P) waste, with small amounts of various other wastes. The best-basis inventory estimates for tank 241-C-104 are presented in Tables 3-1 and 3-2.

Table 3-1. Best-Basis Inventory Estimates for Nonradioactive Components in Tank 241-C-104 (January 31, 1997). (2 sheets)

Analyte	Total Inventory (kg)	Basis (S, M, or E)[1]	Comment
Al	67,450	E	Weiss and Schull (1988), Appendix B
Bi	<4,120	S	
Ca	<4,120	S	
Cl	911	S	
CO_3	55,000	S	
Cr	1,660	S	
F	39,400	S	
Fe	31,400	S	
Hg	664	M	Agnew et. al. (1996b)
K	<1,960	S	
La	<2,060	S	
Mn	6,800	S	
Na	203,000	S	
Ni	3,000	S	

Table 3-1. Best-Basis Inventory Estimates for Nonradioactive Components in Tank 241-C-104 (January 31, 1997). (2 sheets)

Analyte	Total Inventory (kg)	Basis (S, M, or E)[1]	Comment
NO_2	41,600	S	
NO_3	22,300	S	
OH	n/r		
Pb	<4,120	S	
P as PO_4	8,230	S	
Si	11,600	S	
S as SO_4	<12,360	S	
Sr	<412	S	
TOC	16,100	S	
U_{TOTAL}	61,100	S	
Zr	73,900	S	

Notes:

n/r = not reported

[1]S = Sample-based
M = Hanford defined waste model-based
E = Engineering assessment-based

Table 3-2. Best-Basis Inventory Estimates for Radioactive Components in Tank 241-C-104 (Decayed to January 1, 1994). (3 sheets)

Analyte	Total Inventory (Ci)	Basis (S, M, or E)[1]	Comment
^{3}H	n/r		
^{14}C	0.84	S	Weiss and Schull (1988)
^{59}Ni	n/r		
^{60}Co	610	S	Appendix B
^{63}Ni	n/r		
^{79}Se	n/r		

Table 3-2. Best-Basis Inventory Estimates for Radioactive Components in Tank 241-C-104 (Decayed to January 1, 1994). (3 sheets)

Analyte	Total Inventory (Ci)	Basis (S, M, or E)[1]	Comment
^{90}Sr	624,000	S	Appendix B
^{90}Y	624,000	E	Based on ^{90}Sr
^{93}Zr	n/r		
^{93m}Nb	n/r		
^{99}Tc	3,740	S	Weiss and Schull (1988)
^{106}Ru	n/r		
^{113m}Cd	n/r		
^{125}Sb	n/r		
^{126}Sn	n/r		
^{129}I	n/r		
^{134}Cs	n/r		
^{137}Cs	123,000	S	Appendix B
^{137m}Ba	116,000	E	Based on ^{137}Cs
^{151}Sm	n/r		
^{152}Eu	n/r		
^{154}Eu	1,880	S	Appendix B
^{155}Eu	<1,850	S	Appendix B
^{226}Ra	n/r		
^{227}Ac	n/r		
^{228}Ra	n/r		
^{229}Th	n/r		
^{231}Pa	n/r		
^{232}Th	n/r		
^{232}U	n/r		
^{233}U	n/r		

Table 3-2. Best-Basis Inventory Estimates for Radioactive Components in Tank 241-C-104 (Decayed to January 1, 1994). (3 sheets)

Analyte	Total Inventory (Ci)	Basis (S, M, or E)[1]	Comment
^{234}U	n/r		
^{235}U	n/r		
^{236}U	n/r		
^{237}Np	n/r		
^{238}Pu	n/r		
^{238}U			
$^{239/240}Pu$	5,827	S	Appendix B
^{241}Am	7,150	S	Appendix B
^{241}Pu	n/r		
^{242}Cm	n/r		
^{242}Pu	n/r		
^{243}Am	n/r		
^{243}Cm	n/r		
^{244}Cm	n/r		

Notes:

n/r = not reported

[1]S = Sample-based
M = Hanford defined waste model-based
E = Engineering assessment-based

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4.0 RECOMMENDATIONS

Eight samples exceeded the 95 percent confidence interval upper limit for TOC of 3.00E+04 μg/g on a dry weight basis. The mean of three of these samples also exceeded this limit on a dry weight basis. A review of the percent water for these same samples indicates there is sufficient water to prevent a propagating reaction. The low DSC values associated with the relatively high TOC values within these solid samples indicates a majority of the measured carbon is no longer associated with compounds containing hydrogen and is therefore not reactive. One sample (drainable liquid) exceeded the 95 percent confidence interval upper limit for DSC of 480 J/g on a dry weight basis. The percent water for this same sample indicates there is sufficient water to prevent a propagating reaction. According to the organic DQOs decision rule, the tank could be declared "conditionally safe" with respect to organic content.

The historical DQO required the analyses of core composite samples from each core. The core composite data are provided in Appendix B. Further evaluation of the available data will be performed at a later time to determine if the historical model inventories are in agreement with current tank inventories.

The sampling and analysis activities performed for tank 241-C-104 have met all requirements for all of the applicable DQO documents. Furthermore, a characterization best-basis inventory was developed for the tank contents.

Table 4-1 summarizes the status of the Project Hanford Management Contractor (PHMC) TWRS Program review and acceptance of the sampling and analysis results reported in this tank characterization report. All DQO issues required to be addressed by sampling and analysis are listed in column one of Table 4-1. The second column indicates whether the requirements of the DQO were met by the sampling and analysis activities performed and is answered with a "yes" or a "no." The third column indicates concurrence and acceptance by the program in TWRS that is responsible for the DQO that the sampling and analysis activities performed adequately meet the needs of the DQO. A "yes" or "no" in column three indicates acceptance or disapproval of the sampling and analysis information presented in the TCR. If the results/information have not yet been reviewed, "N/R" is shown in the column. If the results/information have been reviewed, but acceptance or disapproval has not been decided, "N/D" is shown in the column.

Table 4-1. Acceptance of Tank 241-C-104 Sampling and Analysis.

Issue/Evaluations	Sampling and Analysis Performed	TWRS[1] Program Acceptance
Safety screening DQO	Yes	Yes
Historical DQO	Yes	Yes
Organic DQO	Yes	Yes
Vapor DQO	Yes	Yes

Note:
[1]PHMC (Project Hanford Management Contractor) TWRS Program Office

Table 4-2 summarizes the status of PHMC Program review and acceptance of the evaluations and other characterization information contained in this report. The evaluations specifically outlined in this report are the historical analysis and the evaluation to determine whether the tank is safe, conditionally safe, or unsafe. Column one lists the different evaluations performed in this report. Columns two and three are in the same format as Table 4-1. The manner in which concurrence and acceptance are summarized is also the same as that in Table 4-1.

Table 4-2. Acceptance of Evaluation of Characterization Data and Information for Tank 241-C-104.

Issue	Evaluation Performed	TWRS[1] Program Acceptance
Historical analysis	N/R	N/R
Safety categorization (Tank is conditionally safe)	Yes	Yes

Note:
[1]PHMC TWRS Program Office

N/R = not reviewed

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[4]This document was modified by engineering change notice (ECN) 164204 issued by K. D. Fowler on September 30, 1991. U and $^{239/240}Pu$ results were corrected. The ECN did not change the revision number of the document.

APPENDIX A

HISTORICAL TANK INFORMATION

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APPENDIX A

HISTORICAL TANK INFORMATION

Appendix A describes tank 241-C-104 based on historical information. For this report, historical information includes any information about the fill history, waste types, surveillance, or modeling data about the tank. This information is necessary for providing a balanced assessment of the sampling and analytical results.

This appendix contains the following information:

- **Section A1:** Current status of the tank, including the current waste levels and the stabilization and isolation status of the tank.

- **Section A2:** Information about the design of the tank.

- **Section A3:** Process knowledge of the tank, that is, the waste transfer history and the estimated contents of the tank based on modeling data.

- **Section A4:** Surveillance data for tank 241-C-104, including surface-level readings, temperatures, and a description of the waste surface based on photographs.

- **Section A5:** References for Appendix A.

Historical sampling results (results from samples obtained before 1989) are included in Appendix B.

A1.0 CURRENT TANK STATUS

As of October 31, 1996, tank 241-C-104 contained an estimated 1120 kL (295 kgal) of waste classified as complex (Hanlon 1997). The solid waste volumes are estimated using a photographic evaluation. The solid waste volume was last updated on September 22, 1989. The amounts of various waste phases in the tank are presented in Table A1-1.

Tank 241-C-104 is out of service, as are all single shell tanks. It is categorized as sound. Interim stabilization was completed September 1989 (Hanlon 1997). Partial isolation (intrusion prevention) was completed December 1982 (Welty 1988) and final interim isolation (intrusion prevention) on September 1990. The tank is not on any Watch List and is passively ventilated (Hanlon 1997). All monitoring systems were in compliance with documented standards as of October 31, 1996 (Hanlon 1997).

Table A1-1. Tank Contents Status Summary (Hanlon 1997).

Waste Type	kL (kgal)
Total waste	1120 (295)
Supernatant liquid	0 (0)
Sludge	1120 (295)
Saltcake	0 (0)
Drainable interstitial liquid	42 (11)
Drainable liquid remaining	42 (11)
Pumpable liquid remaining	20 (5)

A2.0 TANK DESIGN AND BACKGROUND

The 241-C Tank Farm was constructed during 1943 and 1944 in the 200 East Area. The farm contains twelve 100 series tanks and four 200 series tanks. The 100 series tanks have a capacity of 2010 kL (530 kgal) and a diameter of 23 m (75 ft) (Leach and Stahl 1996). Built according to the first generation design, the 241-C Tank Farm was designed for nonboiling waste with a maximum fluid temperature of 104 °C (220 °F) (Brevick et al. 1997). A cascade overflow line 75 mm (3 in.) in diameter connects tank 241-C-104 as first in a cascade series of three tanks ending with tanks 241-C-105 and -106. Each tank in the cascade series is set one foot lower in elevation from the preceding tank.

The tank has a dished bottom with a 1.2-m (4-ft) radius knuckle. Tank 241-C-104 was designed with a primary mild steel liner (ASTM[5] A283 Grade C) and a concrete dome with various risers. The tank is set on a reinforced concrete foundation. The tank and foundation are waterproofed with a coating of tar covered by a three-ply, asphalt impregnated, waterproofing fabric. The waterproofing was protected by a welded-wire-reinforced, cement-like mixture. Two coats of primer were sprayed on all exposed interior tank surfaces. The tank ceiling dome was covered with three applications of magnesium zinc fluorosilicate wash. Lead flashing was used to protect the joint where the steel liner meets the concrete dome. Asbestos gaskets were used to seal the risers in the tank dome (Rogers and Daniels 1944).

[5]American Society for Testing and Materials

Tank 241-C-104 has 12 risers according to the drawings and engineering change notices. The risers range in diameter from 100 mm (4 in.) to 1.1 m (42 in.). Table A2-1 shows numbers, diameters, and descriptions of the risers and the nozzles. A plan view that depicts the riser and nozzle configurations is shown as Figure A2-1. Risers 8 and 14 (102 mm [4 in.]) in diameter and riser 3 (300 mm [12 in.] in diameter) are available for core sampling. Riser 2 (250 mm [10 in.] in diameter) is available for vapor sampling (Lipnicki 1996). A tank cross-section showing the approximate waste level along with a schematic of the tank equipment is in Figure A2-2.

Table A2-1. Riser Configuration for Tank 241-C-104.

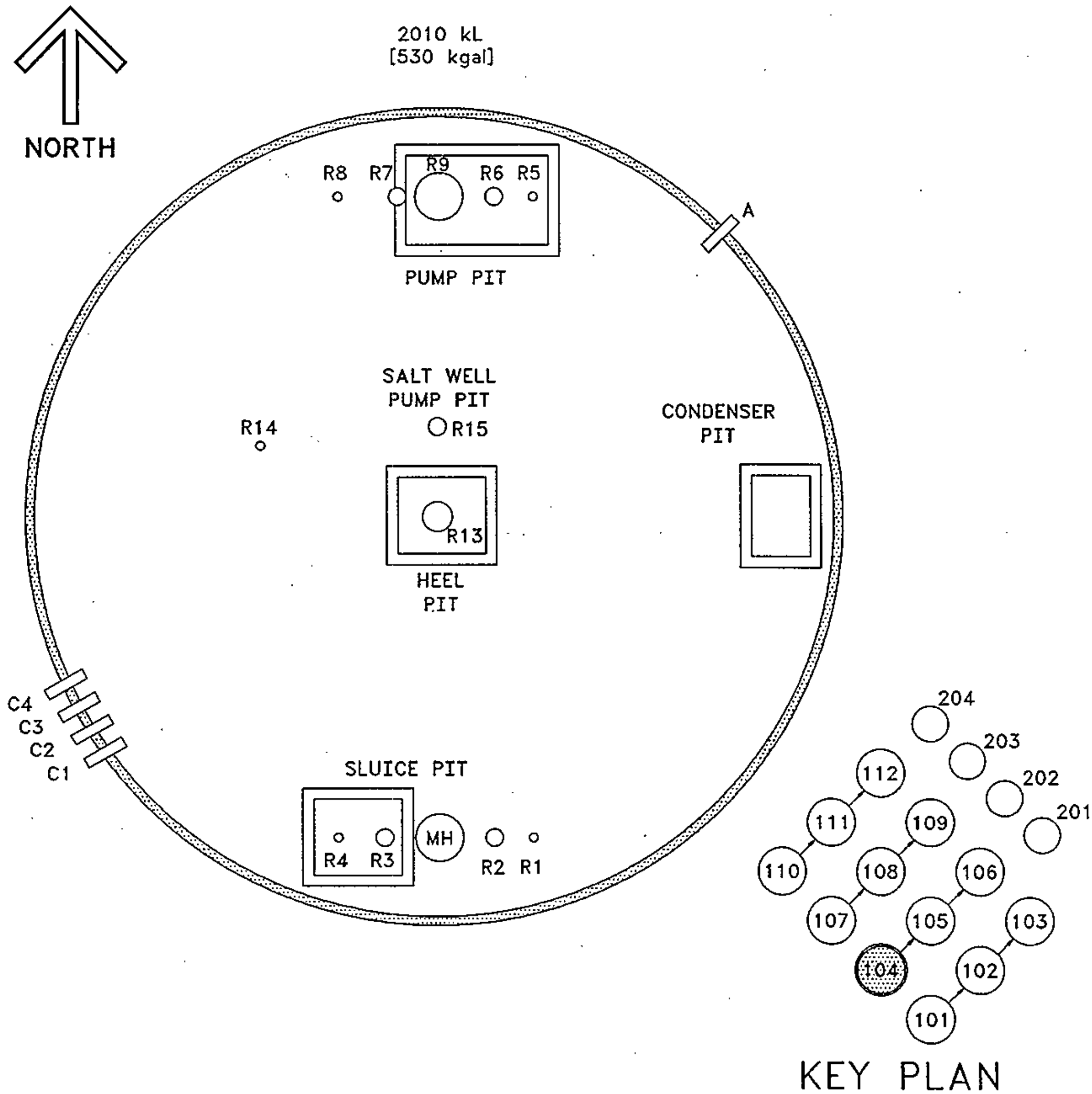
Number	Diameter (inches)	Description and Comments
R1	4	Liquid level well "B"
R2	10	Breather filter (10-in. to 4-in. adapter ECN-192277L 5/18/93)
R3*	12	B-222 observation port
R4	4	Recirculating dip leg, weather covered
R5	4	Recirculating dip leg, weather covered
R6	12	Sluicing access, weather covered
R7	12	Thermocouple tree, flange
R8*	4	Food Instrument Corporation (FIC) gauge
R9	42	Sludge pump, weather covered
R13	26	Salt well riser
R14*	4	Flange
R15	12	Salt well screen and pump
A	3	Overflow outlet
C1	3	Fill line V150
C2	3	Fill line V149, sealed in diversion box 241-C-153
C3	3	Fill line V148, sealed in diversion box 241-C-153
C4	3	Spare, capped

Notes:

ECN = Engineering change notice

*Riser tentatively available for core sampling.
Dates are in mm/dd/yy format.

Figure A2-1. Riser Configuration for Tank 241-C-104.



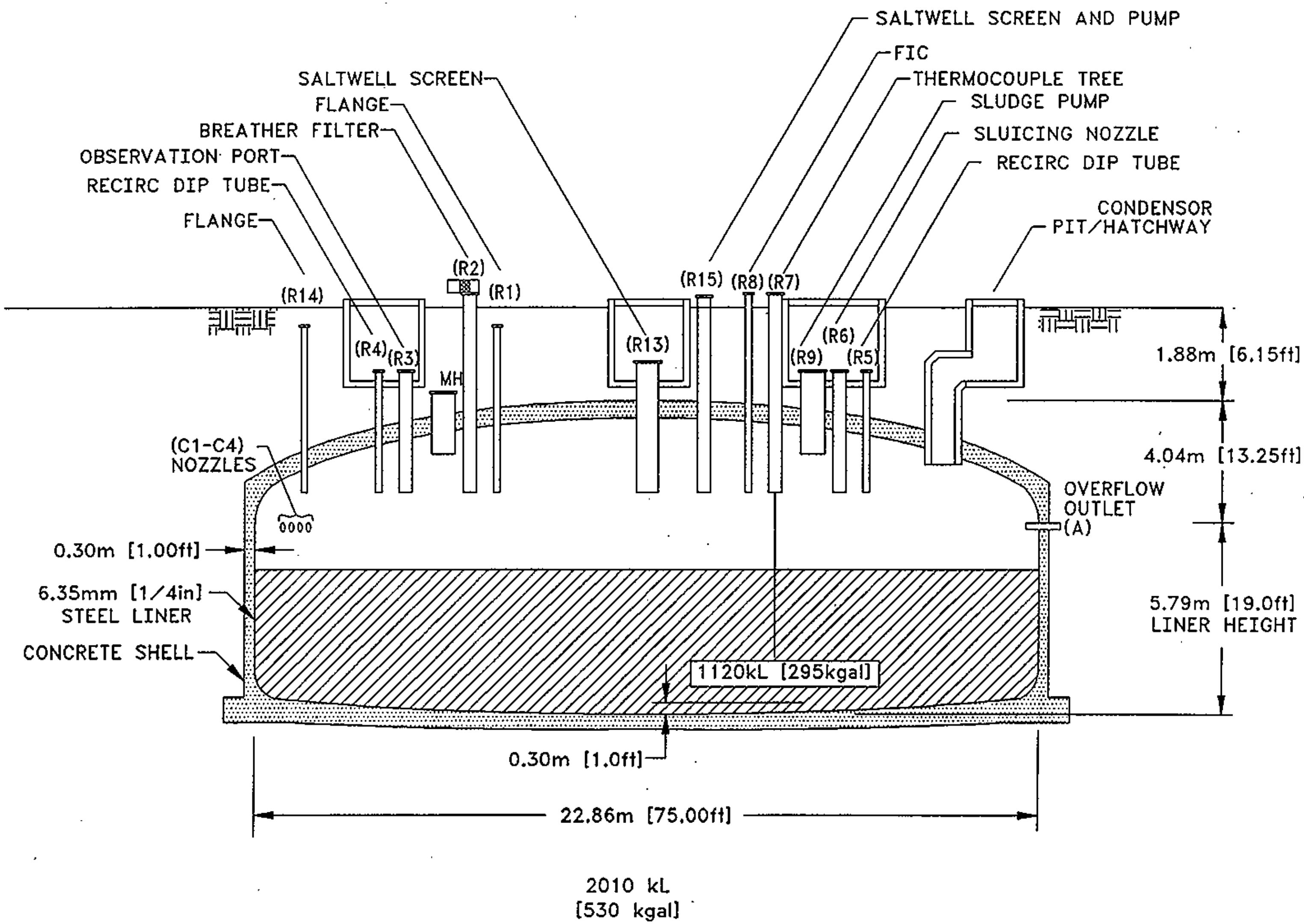


Figure A2-2. Tank 241-C-104 Cross Section and Schematic.

A3.0 PROCESS KNOWLEDGE

The sections below contain the following information.

1) Information about the waste transfer history of tank 241-C-104
2) Description of the process wastes that were transferred
3) An estimate of the tank's current contents based on waste transfer history.

A3.1 WASTE TRANSFER HISTORY

Table A3-1 summarizes the waste transfer history of tank 241-C-104 (Agnew et al. 1997b). The tank first received metal waste from B Plant in the fourth quarter of 1946. The tank began to cascade waste to 241-C-105 during the first quarter of 1947. Tank 241-C-104 continued to receive metal waste until the fourth quarter of 1947 when the tank and cascade series were full. The tank remained full until the second quarter of 1953 when water was added and waste was sent to 241-C-106. The tank was sluiced and the waste was sent to U Plant for uranium recovery during the third and fourth quarters of 1953. Water was added to the tank during the first, second, and fourth quarters of 1954. Metal waste slurry was sent to U Plant for uranium recovery during the third quarter of 1954 and the first quarter of 1955. The tank was empty until the fourth quarter of 1955 when it received tri-butyl phosphate supernatant and metal waste from tank 241-C-112.

The tank received cladding waste from PUREX from the first quarter of 1956 to the second quarter of 1957. Supernatant waste was sent to tanks 241-C-101 and -105 in the first and third quarters of 1956, respectively. Supernatant was cascaded to tank 241-C-105 during the second quarter of 1957.

The tank received supernatant from tank 241-C-105 in the first quarter of 1960. The tank received waste from the 244-CR Vault in the second quarter of 1965. Waste was sent to tank 241-C-102 during the second quarter of 1969. The tank received cladding waste and organic wash waste from PUREX from the fourth quarter of 1969 to the third quarter of 1972. During this time the tank also received supernatant waste from tanks 241-C-107, C-108, C-109, C-110, C-111, C-112, C-201, C-202, C-203, and C-204, and waste was sent to tanks 241-BX-101, BX-103, C-103, and C-105.

The tank received TH waste in the third and fourth quarters of 1970. Also in the fourth quarter of 1970 the tank received PUREX low-level waste and waste from the 244-CR Vault.

In the fourth quarter of 1972 the tank received organic wash waste from PUREX. From the fourth quarter of 1972 to the fourth quarter of 1973, the tank received supernatant waste from tanks 241-A-101, C-103, TY-101, and U-107, and waste was sent to tanks 241-B-103, BX-103, C-103, C-107, and C-108. Supernatant was sent from tanks 241-A-101, A-102, AX-103, C-101, C-103, C-106, and C-111, from the first quarter of 1974 to the first quarter of 1976. during this time, waste was sent from tank 241-C-104 to tanks 241-C-103, S-107, SX-106, TX-101, U-102, and U-106.

Low-level waste was sent from PUREX to tank 241-C-104 in the first and second quarters of 1973; the second, third, and fourth quarters of 1974; the first, third and fourth quarters of 1975; and the first and second quarters of 1976. High-level waste was sent from PUREX to tank 241-C-104 during the fourth quarter of 1973, the first quarter of 1974, and the second quarter of 1975. The tank received waste from the 244-CR Vault during the first quarter of 1974 and water during 1974 and 1975.

In the second quarter of 1976 waste was received from tanks 241-A-103 and 241-C-106 and sent to tank 241-SX-106.

Tank 241-C-104 exchanged supernatant with tank 241-A-102 from 1976 to 1980. Supernatant was sent to tanks 241-AZ-101 and 241-AX-102 in 1978. During the third quarter of 1979, the tank received supernatant from 241-C-103. Salt well liquor was sent to tank 241-AW-105 in the third quarter of 1985.

Table A3-1. Tank 241-C-104 Major Waste Transfers[1,2] (3 sheets)

Transfer Source	Transfer Destination	Waste Type	Time Period	Estimated Waste Volume	
				kL	kgal
B Plant		MW	1946 - 1947	6,018	1,590
	241-C-105	MW	1947	-4,012	-1,060
	241-C-106	SL	1953	-2,010	-530
Misc. Sources		Flush waste	1957, 1959	4,072	1,076
	U Plant	MW	1953, 1954, 1955	-4,073	-1,076
241-C-112		TBP	1955	1,590	420
PUREX		CWP	1956 - 1957	4,220	1,115
	241-C-101, 241-C-105	SU	1956	-3,130	-826
	241-C-105	SU	1957	-678	-179
241-C-105		SU	1960	53	14
244-CR Vault		DW	1965, 1970	210	55
PUREX		CWP, OWW, TH	1969 - 1972	39,542	10,447
	241-C-102	SU	1969	-1,250	-330

Table A3-1. Tank 241-C-104 Major Waste Transfers[1,2] (3 sheets)

Transfer Source	Transfer Destination	Waste Type	Time Period	Estimated Waste Volume kL	kgal
241-C-107, 241-C-111		SU	1969	2,160	572
	241-BX-103	SU	1969 - 1973	-38,524	-10,177
241-C-109, 241-C-112		SU	1970	2,790	737
241-C-201, 241-C-202, 241-C-203, 241-C-204		SU	1970	511	135
PUREX		PL	1970, 1973, 1974 - 1976	1,650	436
	241-BX-101	SU	1970, 1971	-15,490	-4,093
241-C-110		SU	1971	1,230	326
	241-C-103, 241-C-105	SU	1972	-1,780	-471
241-C-107, 241-C-108, 241-C-103		IX, CW, OWW	1972	3,630	960
241-U-107		BNW, DW, EB, N	1972 - 1973	8,550	2,259
241-TY-101		TBP, R	1973	840	222
241-A-101		SU	1973 - 1976	6,162	1,628
	241-B-103	SU	1973	-1,160	-307
	241-C-103, 241-C-107, 241-C-108	SU	1973 - 1974	-3,630	-958
PUREX		P	1973 - 1975	340	91
244-CR Vault		DW	1974	130	35
241-C-103		SU	1974, 1979	1,050	278
241-AX-103, 241-C-111		SU	1974	250	66
	241-S-107	SU	1974	-1,360	-358

Table A3-1. Tank 241-C-104 Major Waste Transfers[1,2] (3 sheets)

Transfer Source	Transfer Destination	Waste Type	Time Period	Estimated Waste Volume kL	Estimated Waste Volume kgal
241-C-106		SU	1975 - 1976	5,000	1,321
	241-TX-101, 241-C-103	SU	1975	-6,601	-1,744
	241-U-106	SU	1975, 1976	-1,520	-402
	241-U-102, 241-SX-106	SU	1976	-4,746	-1,254
241-A-103		SU	1976	3,480	920
241-A-102		SU	1976-1980	3,500	926
	241-A-102	SU	1976-1980	-2,680	-708
	241-AZ-101, 241-AX-102	SU	1978	-1,480	-391
	241-AW-105	SWLIQ	1985	-79	-21

Notes:

BNW = Battelle Northwest Laboratory
CW = aluminum cladding waste
CWP = PUREX cladding waste
DW = decontamination waste
EB = evaporator bottoms
IX = ion exchange waste
MW = Metal waste from the bismuth phosphate process (which extracted plutonium) containing all of the uranium, approximately 90 percent of the original fission product activity, and approximately 1 percent of the product. The term "metal" was the code word for plutonium.
N = N-Reactor decontamination waste (mainly neutralized phosphoric acid).
OWW = organic wash waste from PUREX process
P = PUREX high-level waste
PL = PUREX low-level waste
R = REDOX high-level waste
SL = sludge
SU = supernatant
SQLIQ = dilute, non-complexed waste from 200-East Area single-shell tanks.
SWLIQ = salt waste liquor
TBP = tributyl phosphate (uranium recovery) waste
TH = thoria high-level waste

[1]Agnew et al. (1997b)

[2]Because only major waste transfers are listed, the sum of these transfers will not equal the current tank waste volume.

A3.2 HISTORICAL ESTIMATION OF TANK CONTENTS

The historical transfer data used for this estimate are from the following sources:

- *Waste Status and Transaction Record Summary for the Northeast Quadrant* (WSTRS) (Agnew et al. 1997b). WSTRS is a tank-by-tank quarterly summary spreadsheet of waste transactions.

- *Hanford Tank Chemical and Radionuclide Inventories: HDW Model Rev. 4* (Agnew et al. 1997a). This document contains the Hanford defined waste (HDW) list, the supernatant mixing model (SMM), and the tank layer model (TLM).

- *Historical Tank Content Estimate for the Northeast Quadrant of the Hanford 200 East Area* (HTCE) (Brevick et al. 1995). This document compiles and summarizes much of the process history, design, and technical information regarding the underground waste storage tanks in the northeast quadrant of the 200 areas.

- Tank layer model (TLM). The TLM defines the sludge and saltcake layers in each tank using waste composition and waste transfer information.

- Supernatant mixing model (SMM). This is a subroutine within the HDW model that calculates the volume and composition of certain supernatant blends and concentrates.

Using these records, the TLM defines the sludge and saltcake layers in each tank. The SMM uses information from both the WSTRS and the TLM to describe the supernatants and concentrates in each tank. Together, the WSTRS, TLM, and SMM determine each tank's inventory estimate. These model predictions are considered estimates that require further evaluation using analytical data.

Based on the TLM and SMM, tank 241-C-104 contains a top layer of 20 kL (5 kgal) of SMMA1 above a layer of 42 kL (11 kgal) of strontium recovery sludge (SRR), a layer of 20 kL (6 kgal) of PL, a layer of 4 kL (1 kgal) of PUREX waste from 1968-1972 (P2), a layer of 57 kL (15 kgal) of CWR2, a layer of 4 kL (1 kgal) of P2, a layer of 100 kL (27 kgal) of CWP/Zr, a layer of 120 kL (31 kgal) of OWW3, a layer of 250 kL (66 kgal) of CWP2, a layer of 91 kL (24 kgal) of TH, a layer of 15 kL (4 kgal) of PL, a layer of 11 kL (3 kgal) of CWP2, a layer of 370 kL (98 kgal) of CWP1, and a bottom layer of 11 kL (3 kgal) of MW. Figure A3-1 shows a graph representing the estimated waste type and volumes for the tank layers.

Several waste types have characteristic analytes/concentrations, however, most of the waste volume is cladding waste (AL). The waste types that may be observed are CWP/Zr and thoria waste.

The remaining high-level waste types are not present in sufficient volumes that they can be distinguished from the bulk of the waste with the present means of sampling and analysis. Table A3-2 shows an estimate of the expected waste constituents and their concentrations.

Figure A3-1. Tank Layer Model.

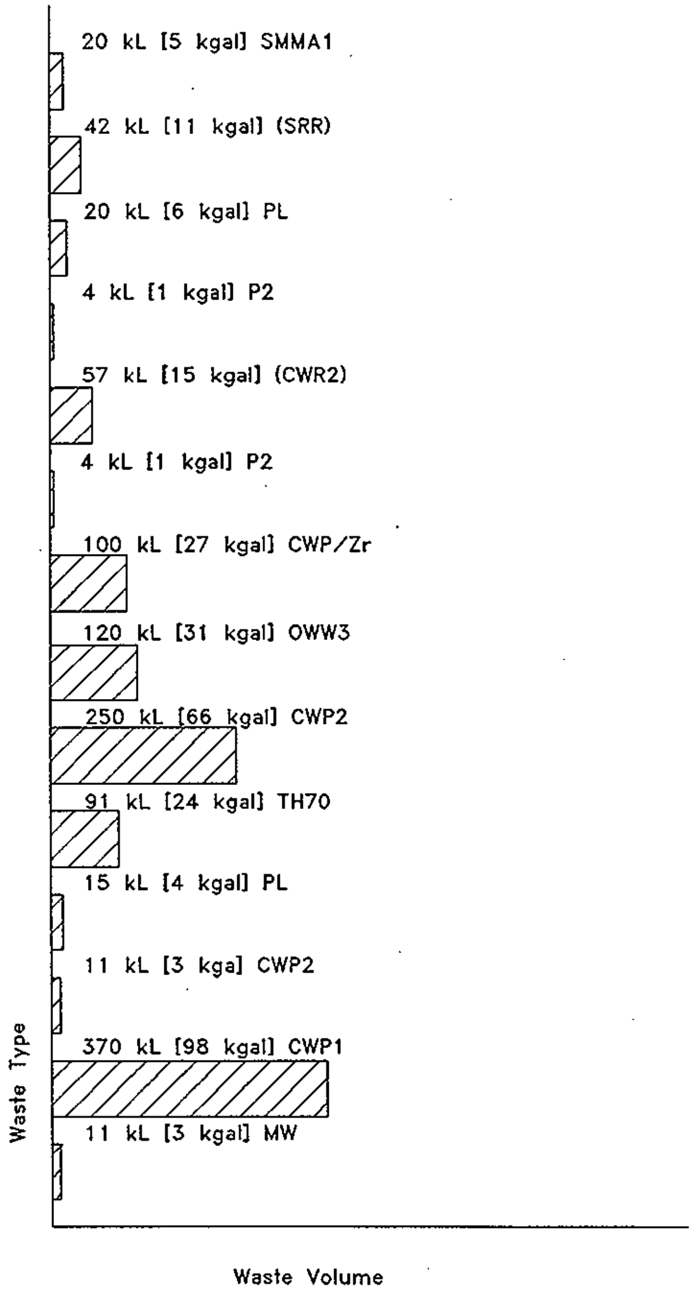


Table A3-2. Historical Tank Inventory Estimate.[1,2] (4 sheets)

Total Inventory Estimate			
Physical Properties			
Total solid waste	1.63E+06 kg (295 kgal)		
Heat load	3.70 kW (1.26E+04 Btu/hr)		
Bulk density	1.46 (g/cm^3)		
Water wt%	53.5		
Total Organic Carbon wt% Carbon (wet)	0.169		
Chemical Constituents	*M*	µg/g	kg[3]
Na^{+}	2.58	4.07E+04	6.63E+04
Al^{3+}	3.45	6.39E+04	1.04E+05
Fe^{3+} (total Fe)	1.12	4.27E+04	6.97E+04
Cr^{3+}	4.41E-03	157	256
Bi^{3+}	1.21E-05	1.73	2.83
La^{3+}	2.45E-07	2.32E-02	3.80E-02
Hg^{2+}	2.97E-03	407	664
Zr (as $ZrO(OH)_2$)	8.48E-02	5.30E+03	8.64E+03
Pb^{2+}	0.132	1.87E+04	3.05E+04
Ni^{2+}	4.67E-02	1.88E+03	3.06E+03
Sr^{2+}	0	0	0
Mn^{4+}	1.01E-04	3.81	6.21
Ca^{2+}	0.337	9.25E+03	1.51E+04
K^{1+}	2.26E-02	605	986
OH^{-}	15.9	1.86E+05	3.02E+05
NO_3^{-}	0.825	3.5E+04	5.71E+04
NO_2^{-}	0.402	1.27E+04	2.07E+04
CO_3^{2-}	0.387	1.59E+04	2.59E+04
PO_4^{3-}	1.42E-02	920	1.50E+03

Table A3-2. Historical Tank Inventory Estimate.[1,2] (4 sheets)

Total Inventory Estimate			
Chemical Constituents (Cont'd)	*M*	μg/g	kg[3]
SO_4^{2-}	1.99E-02	1.31E+03	2.14E+03
Si (as SiO_3^{2-})	8.39E-02	1.61E+03	2.63E+03
F^-	0.494	6.42E+03	1.05E+04
Cl^-	1.75E-02	424	692
$C_6H_5O_7^{3-}$	3.10E-04	40.1	65.5
$EDTA^{4-}$	5.24E-03	1.03E+03	1.68E+03
$HEDTA^{3-}$	1.04E-02	1.95E+03	3.19E+03
glycolate$^-$	1.16E-02	566	923
acetate$^-$	2.11E-04	8.54	13.9
oxalate^{2-}	3.21E-07	1.94E-02	3.16E-02
DBP	2.10E-03	302	492
Butanol	2.10E-03	106	174
Chemical Constituents	*M*	μg/g	kg[3]
NH_3	6.84E-02	796	1.30E+03
$Fe(CN)_6^{4-}$	0	0	0
Radiological Constituents	*M*	μg/g	kg[3]
Pu	3.52E-02 g/L		39.3 (kg)
U	0.167	2.73E+04	4.45E+04
Radiological Constituents	Ci/L	μCi/g	Ci
H-3	9.12E-06	6.24E-03	10.2
C-14	9.42E-07	6.45E-04	1.05
Ni-59	2.36E-05	1.61E-02	26.3
Ni-63	2.32E-03	1.59	2.59E+03
Ce-60	1.39E-06	9.52E-04	1.55
Se-79	1.35E-05	9.25E-03	15.1
Sr-90	0.478	327	5.34E+05
Y-90	0.478	327	5.34E+05
Zr-93	5.86E-05	4.01E-02	65.5
Nb-93m	4.99E-05	3.41E-02	55.7

Table A3-2. Historical Tank Inventory Estimate.[1,2] (4 sheets)

Total Inventory Estimate			
Radiological Constituents (Cont'd)	Ci/L	μCi/g	Ci
Te-99	6.86E-06	4.69E-03	7.66
Ru-106	1.02E-07	6.98E-05	0.114
Cd-113m	1.33E-04	9.13E-02	149
Sb-125	8.24E-06	5.64E-03	9.20
Sn-126	2.17E-05	1.48E-02	24.2
I-129	1.40E-08	9.60E-06	1.57E-02
Cs-134	6.57E-07	4.50E-04	0.734
Cs-137	1.91E-02	13.1	213E+04
Ba-137m	1.81E-02	12.4	2.02E+04
Sm-151	5.05E-02	34.5	5.63E+04
Eu-152	1.34E-05	9.15E-03	14.9
Eu-154	3.41E-04	0.234	381
Eu-155	8.28E-04	0.56	924
Ra-226	4.37E-09	2.99E-06	4.88E-03
Ra-228	1.99E-05	1.36E-02	22.2
Ac-227	6.22E-05	4.26E-02	69.4
Pa-231	1.12E-04	7.66E-02	125
Th-229	4.42E-07	3.02E-04	0.493
Th-232	1.10E-06	7.55E-04	1.23
U-232	1.70E-05	1.16E-02	18.9
U-233	6.50E-05	4.45E-02	72.5
U-234	1.57E-05	1.08E-02	17.6
U-235	6.19E-07	4.23E-04	0.69
U-236	6.93E-07	4.74E-04	0.77
U-238	1.33E-05	9.10E-03	148
Np-237	2.50E-08	1.71E-05	2.79E-02
Pu-238	9.11E-05	6.23E-02	102
Pu-239	2.07E-03	1.42	2.32E+03
Pu-240	4.08E-04	0.27	456

Table A3-2. Historical Tank Inventory Estimate.[1,2] (4 sheets)

Total Inventory Estimate			
Radiological Constituents (Cont'd)	Ci/L	μCi/g	Ci
Pu-241	6.17E-03	4.22	6.89E+03
Pu-242	3.60E-08	2.46E-05	4.01E-02
Am-241	5.66E-04	0.38	632
Am-243	2.93E-08	2.00E-05	3.27E-02
Cm-242	5.22E-07	3.57E-04	0.582
Cm-243	4.79E-08	3.28E-05	5.35E-02
Cm-244	1.84E-06	1.26E-03	2.05

Notes:

[1]Agnew et al. (1997a)

[2]These predictions have not been validated and should be used with caution.

[3]Differences exist among the inventories in this column and the inventories calculated from the two sets of concentrations.

A4.0 SURVEILLANCE DATA

Tank 241-C-104 surveillance includes surface level measurements (liquid and solid) and temperature monitoring inside the tank (waste and headspace). The data provide the basis for determining tank integrity.

Liquid level measurement may indicate if there is a major leak from a tank. Solid surface level measurements provide an indication of physical changes and consistency of the solid layers.

A4.1 SURFACE LEVEL READINGS

A Food Instrument Corporation gauge is used to monitor the waste surface level in tank 241-C-104 through riser 8. On November 5, 1996, the waste surface level was 2.19 m (86.4 in.), as measured by the manual FIC gauge. A graphical representation of the volume measurements is presented as a level history graph in Figure A4-1.

A4.2 DRY WELL READINGS

Tank 241-C-104 has seven dry wells. Four of them, dry wells 30-04-02 (active prior to 1990, current activity: one reading >50 c/s), 30-04-03 (active prior to 1990, current readings >200 c/s), 30-04-04 (active prior to 1990, current readings <200 c/s), and 30-04-08 (active prior to 1990, current readings <200 c/s) have or have had readings greater than the 50 c/s background radiation.

A4.3 INTERNAL TANK TEMPERATURES

Tank 241-C-104 has a single thermocouple tree, located in riser 7, with 12 thermocouples to monitor the waste temperature. Elevations are available for all of the thermocouples. Temperature data recorded from January 23, 1976 through November 5, 1996 were obtained from the Surveillance Analysis Computer System (SACS) for all 12 thermocouples. Currently, only thermocouples 1, 3, 6, and 8 are recording data.

From the SACS data, the average temperature was 34 °C (94 °F), the minimum was 12 °C (53 °F), and the maximum was 91 °C (195 °F). The average temperature of the SACS data over the last year (November 1995 through November 1996) was 33 °C (92 °F), the minimum was 28 °C (82 °F), and the maximum was 38 °C (100 °F). The maximum temperature on November 5, 1996 was 37 °C (98 °F) on thermocouple 1 and the minimum was 32 °C (90 °F) on thermocouples 6 and 8.

Thermocouples 1 and 2 are located in the waste while thermocouples 6 and 8 are in the headspace. A graph of the weekly high temperatures can be found in Figure A4-2. The data between July 1975 and March 1994 may be considered suspect and are not labeled as reliable data in SACS. Plots of the individual thermocouple readings can be found in the C Tank Farm Supporting Document for the HTCE (Brevick et al. 1997).

A4.4 TANK 241-C-104 PHOTOGRAPHS

The July 1990 photographic montage of tank 241-C-104's interior (Brevick et al. 1997) is hazy with many color variations. The surface of the waste appears to be very dry. Various pieces of equipment and risers that are identifiable have been labeled. The waste level has not changed since the photographs were taken; therefore, this photographic montage should accurately represent the current appearance of the tank's waste.

Figure A4-1. Tank 241-C-104 Level History.

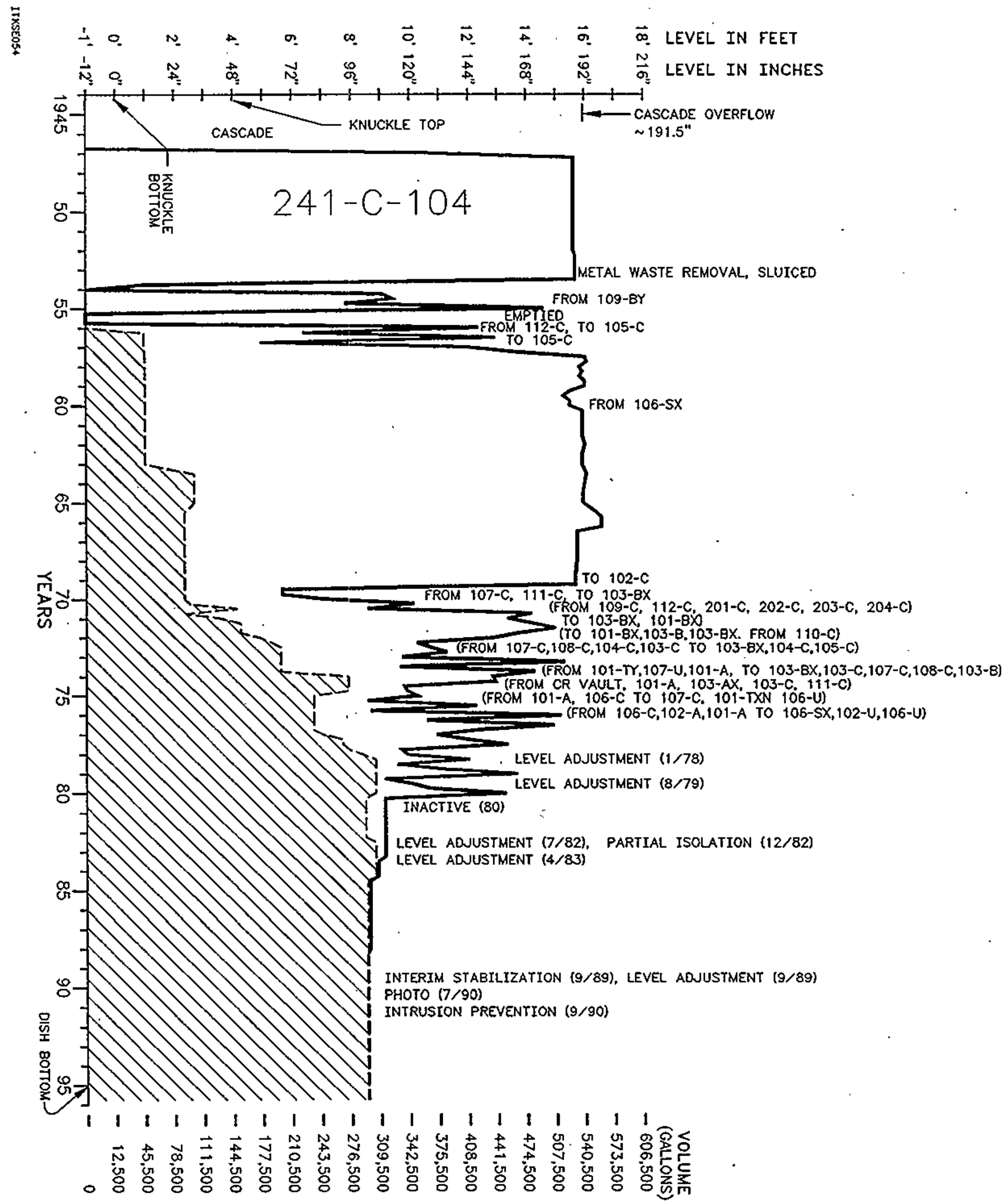
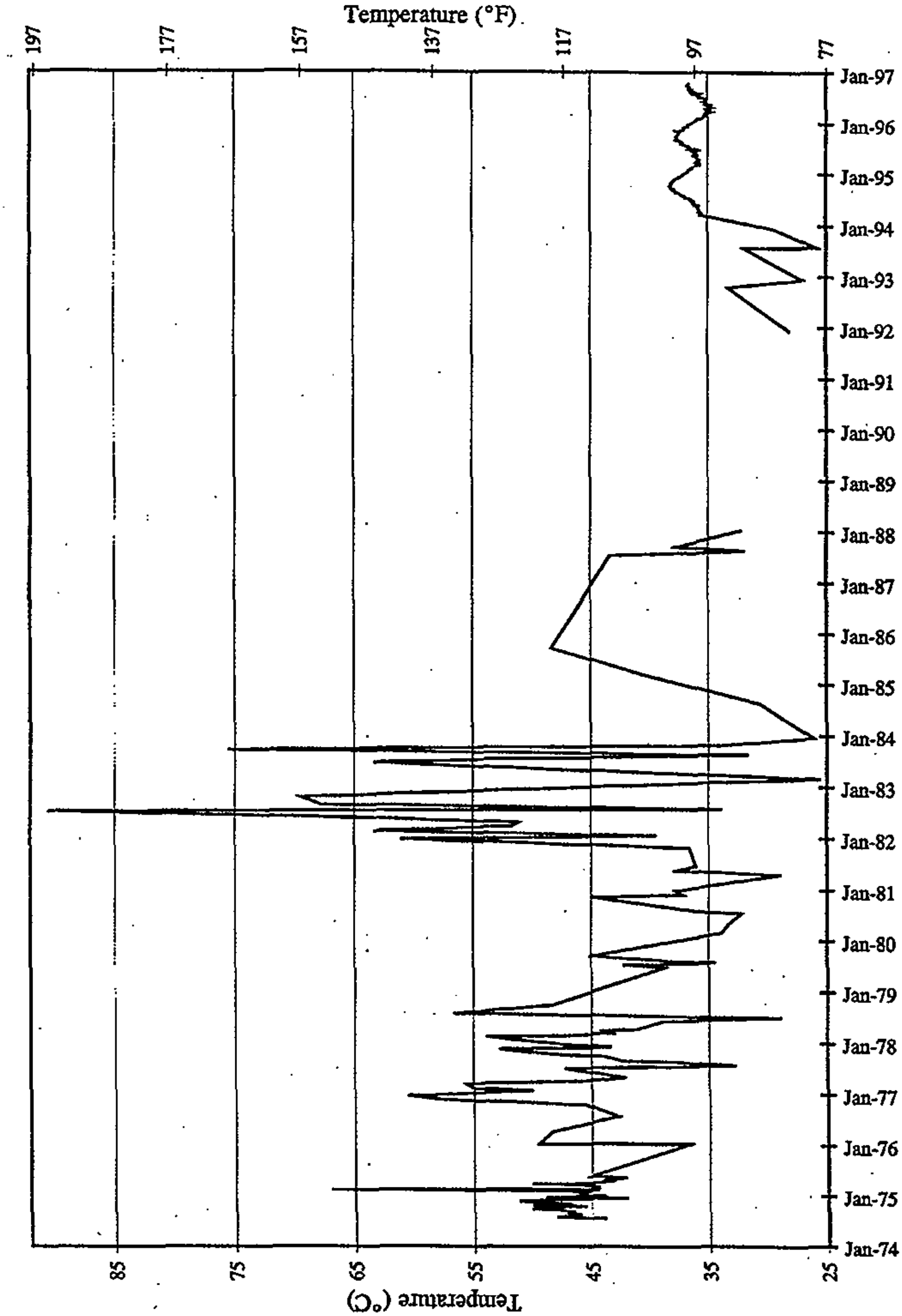


Figure A4-2. Tank 241-C-104 Weekly High Temperature Plot.



A5.0 APPENDIX A REFERENCES

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APPENDIX B

SAMPLING OF TANK 241-C-104

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APPENDIX B

SAMPLING OF TANK 241-C-104

Appendix B provides sampling and analysis information for each known sampling event for tank 241-C-104 and provides an assessment of the push mode sample results.

- **Section B1:** Tank Sampling Overview
- **Section B2:** Analytical Results
- **Section B3:** Assessment of Characterization Results
- **Section B4:** References for Appendix B.

Future sampling of tank 241-C-104 will be appended to the above list.

B1.0 TANK SAMPLING OVERVIEW

This section describes the July 1996 sampling and analysis events for tank 241-C-104. Push Mode samples were taken to satisfy the requirements of the *Tank Safety Screening Data Quality Objective* (Dukelow et al. 1995), and the *Historical Model Evaluation Data Requirements* (Simpson and McCain 1996). The sampling and analyses were performed in accordance with the *Tank 241-C-104 Sampling and Analysis Plan* (Homi 1996). Further discussions of the sampling and analysis procedures can be found in the *Tank Characterization Reference Guide* (De Lorenzo et al. 1994). A sample was taken from this tank in April, 1986, and discussed in Section B2.6.

B1.1 DESCRIPTION OF SAMPLING EVENT

Two push mode core samples were collected from tank 241-C-104. Core sample 162 (four segments) was collected from riser 3 on July 29, 1996 and extruded at the 222-S Laboratory on August 8, 1996 (segment 3) and September 3, 1996 (segments 1, 2 and 4). Core sample 165 (six segments) was obtained from riser 14 on July 30-31, 1996 and extruded by the 222-S Laboratory on August 7, 1996 (segments 1 and 2), September 4, 1996 (segments 3, 4 and 6), and September 6, 1996 (segment 5).

Core sampling was used because of the depth of the waste and the expectation that a full vertical profile of the waste would be obtained. Core 162 from riser 3 contained 4 segments, with the top of first segment located approximately 25.4 cm (10 in.) below the top of the sludge surface and the bottom of segment 4 about 2.54 cm (1 in.) above the bottom of the tank because of an undocumented offset in the elevation of the riser spool. The second core, core 165 from riser 14, was a full-depth core consisting of 6 segments.

Table D2-1 provides data on the segment recoveries from the cores together with the projected depth of the sludge layer based on the physical dimensions of the sampler. Each segment is 48.3 cm (19 in.) long, 2.54 cm (1 in.) in diameter, and has a maximum volume of 244.5 cm^3 (14.9 $in.^3$). Segment recoveries were identified as percent recovered based on the theoretical volume of the sampler. These cores show that the average sludge depth beneath the risers is about 253.6 cm (99.8 in.), which is higher than the measured depth of 221.7 cm (87.3 in.) as of January, 1993 (Swaney 1993) but slightly lower than the 260.9 cm (102.7 in.) depth cited by Hanlon in the Waste Status Summary Report (Hanlon 1997).

A vertical profile is used to satisfy the safety screening data quality objective (DQO). Safety screening analyses include: total alpha to determine criticality, differential scanning calorimetry (DSC) to ascertain the fuel energy value, and thermogravimetric analysis (TGA) to obtain the total moisture content. In addition, combustible gas meter readings in the tank headspace were performed to measure flammability.

Tank 241-C-104 was evaluated against the historical model requirements. Historical model analyses include: DSC, TGA, inductively coupled plasma (ICP), and ion chromatography (IC). The full range of analytes is required for both ICP and IC analyses.

Sampling and analytical requirements from the safety screening and historical DQOs are summarized in Table B1-1.

B1.2 SAMPLE HANDLING

Core 162

Four push mode core segments were removed from tank 241-C-104 riser 3 on July 29, 1996. All segments were received by the 222-S Laboratory between August 1, 1996 and August 28, 1996. Table B1-2 gives the subsampling scheme and sample description.

Core 165

Six push mode core segments were removed from tank 241-C-104 riser 14 between July 30, 1996 and July 31, 1996. All segments were received by the 222-S Laboratory between August 1, 1996 and August 28, 1996. Table B1-2 gives the subsampling scheme and sample description.

Table B1-1. Integrated Data Quality Objective Requirements for Tank 241-C-104.[1,2,3]

Sampling Event	Applicable DQOs	Sampling Requirements	Analytical Requirements
Push mode core sampling	Safety screening	Core samples from a minimum of two risers separated radially to the maximum extent possible.	▸Energetics ▸Separable organics ▸Moisture content ▸Total alpha ▸Density
	Organic screening	Core samples from a minimum of two risers separated radially to the maximum extent possible.	▸Energetics ▸Moisture content ▸TOC
	Historical model	A minimum of two cores. Efforts should be made to obtain thick, layered segments from widely separated areas of the tank.	▸Energetics ▸Moisture content ▸Cations ▸Anions ▸Radionuclides
Vapor sampling	Vapor	Measurement in a minimum of one location within tank headspace.	▸Flammable gas ▸Permanent gases ▸Organic vapors

Notes:

[1]Dukelow et al. (1995)
[2]Turner et al. (1995)
[3]Osborne and Buckley (1995)

Field Blank

The field blank sample was prepared on August 16, 1996 and received by the 222-S Laboratory on August 28, 1996. The material recovered was treated as a drainable liquid as directed by the Tank Sampling and Analysis Plan (TSAP) (Homi 1996).

Hydrostatic Head Fluid Blank

There is no indication of the use of hydrostatic head fluid in procuring these samples. A blank was not provided to the 222-S Laboratory.

Following extrusion, composites of each core were made to support the historical DQO (Simpson and McCain 1996) sampling requirements.

Table B1-2. Tank 241-C-104 Subsampling Scheme and Sample Description.[1] (2 sheets)

Customer Id	Core 162 Segment	Inches Extruded*	Liquid Recovered (g)	Solids Recovered (g)	Sample Description
Blank H_2O	Blank	0.0	256.8--drainable	0.0	The drainable liquid was clear and colorless. No organic layer was observed.
96-392	1	17.0	0.0	191.6--upper half 192.2--lower half	The sample resembled a wet sludge. The solids were light tan at the lower end darkening to a brown color at the upper end. The core was yellow.
96-393	2	18.5	0.0	203.6--upper half 197.2--lower half	The sample resembled a wet sludge. The solids were a black to very dark brown; slightly lighter at the upper end.
96-394	3	17.0	38.7--drainable	130.0--upper half 220.3--lower half	The sample resembled a wet sludge. The solids were yellow at the lower end darkening to a dark brown at the upper end. The drainable liquid was greenish-brown and opaque. No organic layer was observed.
96-395	4	14.5	42.9--drainable	239.2--upper half 153.9--lower half	The lower half solids resembled a wet sludge; the upper half solids resembled a sludge slurry. The solids were tan at the lower end and lightened to a cream color at the upper end. Drainable liquids were recovered approximately half-way through the extrusion. The liquid was tan and opaque. No organic layer was observed.

Table B1-2. Tank 241-C-104 Subsampling Scheme and Sample Description.[1] (2 sheets)

Customer Id	Core 165 Segment	Inches Extruded*	Liquid Recovered (g)	Solids Recovered (g)	Sample Description
96-439	1	3.5	0.0	77.4--lower half	The sample resembled a wet sludge. The solids were dark brown.
96-440	2	19.0	0.0	196.5--upper half 219.2--lower half	The sample resembled a wet sludge. The lower half solids were yellow with some brown coloration on the outside. The upper half was brown.
96-441	3	19.0	0.0	87.5--qtr seg: A 111.6--qtr seg: B 194.8--qtr seg: C	The sample resembled a wet sludge. The lower end was light brown with a yellow core. The middle portion was brown throughout. The upper end was yellow throughout with some brown coloration on the outside and appeared slightly drier than the rest of sample.
96-442	4	19.0	0.0	196.3--qtr seg: A 162.5--qtr seg: B 39.6--qtr seg: C	The sample resembled a dry sludge. The lower end was brown. The upper end was tan. The upper end appeared slightly more wet than the rest of the segment.
96-443	5	17.0	0.0	205.8--upper half 183.0--lower half	The sample resembled a wet sludge. The lower end was black with a yellow core. The upper end was black throughout.
96-444	6	18.0	0.0	131.0--qtr seg: A 31.6--qtr seg: B 75.9--qtr seg: C 154.3--qtr seg: D	The sample resembled a wet sludge. Quarter segment A was brown with a yellow core; quarter segment B was black with small hard crystals; quarter segment C was dark gray with a yellow core; quarter segment D was tan with an orange-yellow core. A very small amount of drainable liquid was extruded and included with the solids.

Note:

[1]Fritts (1996)

B1.3 SAMPLE ANALYSIS

The analyses performed on the push mode core samples were limited to those required by the safety screening DQO, the historical model evaluation DQO and the organic DQO. The analyses required by the safety screening DQO included analyses for thermal properties by DSC, moisture content by TGA, content of fissile material by total alpha activity analysis density and specific gravity. The historical DQO included a full set of analytes to be analyzed by IC and ICP. The organic DQO required analysis for total organic carbon TOC.

Differential scanning calorimetry and TGA were performed on all samples. Quality control tests included performing the analyses in duplicate, and the use of standards.

Total alpha activity measurements were performed on segment samples that had been fused in a solution of potassium and then dissolved in acid. The resulting solution was then dried on a counting planchet and counted in an alpha proportional counter. Quality control tests included standards, spikes, blanks, and duplicate analyses.

Ion chromatography was performed on all samples and were prepared by water digestion. Quality control tests included standards, spikes, blanks, and duplicate analyses. The sampling analysis plan (SAP) required that the full suite of IC analytes be measured.

Inductively coupled plasma spectroscopy was performed on all samples and were prepared by a fusion procedure, followed by dissolution in acid. Quality control tests included standards, blanks, spikes, and duplicate analyses. The SAP (Homi 1996) required that the full suite of ICP elements be analyzed.

Bulk density was determined for all samples by centrifuging a sample portion and measuring the sample volume and mass. Quality control tests included standards and duplicates.

Specific gravity was determined for all samples by gravimetry. Quality control tests included standards and duplicates.

For the historical DQO, a composite of each core was made. In addition to the fusion digest, these samples were also prepared with acid and water digests for the inductively coupled plasma analyses. Total beta counting, as well as analysis for strontium-90 and uranium were also performed on these samples. Quality control tests included standards, blanks, spikes, and duplicate analyses. The SAP required that the full suite of ICP elements be analyzed for each digestion type.

All reported analyses were performed in accordance with approved laboratory procedures. A list of the sample numbers and applicable analyses is presented in Table B1-3. The procedure numbers are presented in the discussion in Section B2.0.

Table B1-3. Tank 241-C-104 Sample Analysis Summary. (4 sheets)

Core	Sample Portion	Sample Number	Analysis
162	Core composite	S96T004947	TGA, DSC, TIC, TOC
		S96T004949	ICP-fusion, GEA, total beta, strontium-89/90, uranium
		S96T004950	ICP-acid digest
		S96T004951	IC
		S96T004952	ICP-H_20 acid digest
162	S1 lower half	S96T004835	Bulk density
		S96T004841	TGA, DSC, TIC, TOC
		S96T004853	Total alpha, ICP-fusion, GEA
		S96T004857	IC
162	S1 upper half	S96T004838	TGA, DSC, TIC, TOC
		S96T004850	ICP-fusion, GEA
		S96T004856	IC
162	S2 lower half	S96T004836	Bulk density
		S96T004842	TGA, DSC, TIC, TOC
		S96T004854	Total alpha, ICP-fusion, GEA
		S96T004859	IC
162	S2 upper half	S96T004839	TGA, DSC, TIC, TOC
		S96T004851	ICP-fusion, GEA
		S96T004858	IC
162	S3 drainable liquid	S96T004363	TGA, DSC, TIC, TOC, total alpha, GEA, ICP-acid dilution, IC, specific gravity
162	S3 lower half	S96T004365	Bulk density
		S96T004366	TGA, DSC, TIC, TOC
		S96T004368	Total alpha, ICP-fusion, GEA
		S96T004369	IC
162	S3 upper half	S96T004358	TGA, DSC, TIC, TOC
		S96T004360	ICP-fusion, GEA
		S96T004361	IC

Table B1-3. Tank 241-C-104 Sample Analysis Summary. (4 sheets)

Core	Sample Portion	Sample Number	Analysis
162	S4 drainable liquid	S96T004828	TGA, DSC, TIC, TOC, total alpha, GEA, ICP-acid dilution, IC, specific gravity
162	S4 lower half	S96T004837	Bulk density
		S96T004843	TGA, DSC, TIC, TOC
		S96T004843	TGA, DSC, TIC, TOC
		S96T004855	Total alpha, ICP-fusion, GEA
		S96T004861	IC
162	S4 upper half	S96T004840	TGA, DSC, TIC, TOC
		S96T004852	ICP-fusion, GEA
		S96T004860	IC
165	Core composite	S96T004954	TGA, DSC, TIC, TOC
		S96T004956	ICP-fusion, GEA, total beta, strontium-89/90, uranium
		S96T004957	ICP-acid digest
		S96T004958	IC
		S96T004959	ICP-H_20 acid digest
165	S1 lower half	S96T004375	Bulk density
		S96T004380	Total alpha, ICP-fusion, GEA
		S96T005360	TGA, DSC, TIC, TOC
		S96T005968	IC
165	S2 lower half	S96T004376	Bulk density
		S96T004379	TGA, DSC, TIC, TOC
		S96T004381	Total alpha, ICP-fusion, GEA
		S96T004383	IC
165	S2 upper half	S96T004371	TGA, DSC, TIC, TOC
		S96T004373	ICP-fusion, GEA
		S96T004374	IC
165	S3 subsegment A	S96T004872	TGA, DSC, TIC, TOC
		S96T004889	Total alpha, ICP-fusion, GEA
		S96T004899	IC

Table B1-3. Tank 241-C-104 Sample Analysis Summary. (4 sheets)

Core	Sample Portion	Sample Number	Analysis
165	S3 subsegment B	S96T004866	Bulk density
		S96T004873	TGA, DSC, TIC, TOC
		S96T004893	Total alpha, ICP-fusion, GEA, Am-241, Cm-243/244, Pu-238, Pu-239/240, uranium
		S96T004900	IC
165	S3 subsegment C	S96T004867	Bulk density
		S96T004874	TGA, DSC, TIC, TOC
		S96T004894	Total alpha, ICP-fusion, GEA
		S96T004901	IC
165	S4 subsegment A	S96T004875	TGA, DSC, TIC, TOC
		S96T004890	ICP-fusion, GEA
		S96T004902	IC
165	S4 subsegment B	S96T004868	Bulk density
		S96T004876	TGA, DSC, TIC, TOC
		S96T004895	Total alpha, ICP-fusion, GEA
		S96T004903	IC
165	S4 subsegment C	S96T004869	Bulk density
		S96T004877	TGA, DSC, TIC, TOC
		S96T004896	Total alpha, ICP-fusion, GEA
		S96T004904	IC
165	S5 lower half	S96T004918	Bulk density
		S96T004920	TGA, DSC, TIC, TOC
		S96T004924	Total alpha, ICP-fusion, GEA
		S96T004926	IC
165	S5 upper half	S96T004919	TGA, DSC, TIC, TOC
		S96T004919	DSC
		S96T004923	ICP-fusion, GEA
		S96T004925	IC

Table B1-3. Tank 241-C-104 Sample Analysis Summary. (4 sheets)

Core	Sample Portion	Sample Number	Analysis
165	S6 subsegment A	S96T004878	TGA, DSC, TIC, TOC
		S96T004891	ICP-fusion, GEA
		S96T004905	IC
165	S6 subsegment B	S96T004879	TGA, DSC, TIC, TOC
		S96T004892	ICP-fusion, GEA
		S96T004906	IC
165	S6 subsegment C	S96T004870	Bulk density
		S96T004880	TGA, DSC, TIC, TOC
		S96T004897	Total alpha, ICP-fusion, GEA
		S96T004907	IC
165	S6 subsegment D	S96T004871	Bulk density
		S96T004881	TGA, DSC, TIC, TOC
		S96T004898	Total alpha, ICP-fusion, GEA
		S96T004908	IC

B1.4 DESCRIPTION OF 1994 VAPOR SAMPLING

Tank 241-C-104 headspace gas and vapor samples were collected and analyzed to help determine the potential risks to the tank farm workers due to fugitive emissions from the tank. The drivers and objectives of waste tank headspace sampling and analysis are discussed in *Program Plan for the Resolution of Tank Vapor Issues* (Osborne and Huckaby 1994). Tank 241-C-104 was vapor sampled in accordance with *Data Quality Objectives for Generic In-Tank Health and Safety Issue Resolution* (Osborne et al. 1994)

Headspace gas and vapor samples were collected from tank 241-C-104 using the vapor sampling system (VSS) on February 17 and March 3, 1994 by Westinghouse Hanford Company (WHC) Sampling and Mobile Laboratories. Air from the tank 241-C-104 headspace was withdrawn via a heated sampling probe mounted in riser 2, and transferred via heated tubing to the VSS sampling manifold. All heated zones of the VSS were maintained at approximately 50 °C (122 °F).

B1.4.1 Sample Handling and Analysis (1994 Vapor Samples)

Sampling media were prepared and analyzed by WHC, Oak Ridge National Laboratories, Pacific Northwest National Laboratories (PNNL), and Oregon Graduate Institute of Science and Technology through a contract with Sandia National Laboratories. Laboratory, sampling devices, sample volumes, analytes, and number of samples are shown in Table B1-4.

B2.0 ANALYTICAL RESULTS

B2.1 OVERVIEW

This section summarizes the sampling and analytical results associated with the July 1996 sampling and analysis of tank 241-C-104. The location of the analytical results associated with this tank are presented in Table B2-1. These results are documented in Fritts (1996), Fritts (1996, 1997), and the vapor results are reported in Lucke et al. (1995).

Table B2-1. Analytical Presentation Tables.

Analysis	Table Number
Total alpha activity	B2-53
Percent water	B2-2
Differential scanning calorimetry	B2-3
Summary data for metals by ICP	B2-8 through B2-44
Anions by IC	B2-45 through B2-52

The four quality control (QC) parameters assessed in conjunction with the tank 241-C-104 samples were standard recoveries, spike recoveries, duplicate analyses, relative percent difference (RPDs), and blanks. The QC criteria specified in the SAP (Homi 1996) were either 85-115, 80-120, 75-125, or 70-130 percent recovery for standards and spikes and ≤ 30 or ≤ 15 percent for RPDs, depending on the analyte. The only QC parameter for which limits are not specified in the SAP is blank contamination. The limits for blanks are set forth in guidelines followed by the laboratory, and all data results presented in this report have met those guidelines. Sample and duplicate pairs in which any of the QC parameters were outside of these limits are footnoted in the sample mean column of the following data summary tables with an a, b, c, d, or e as follows:

- "a" indicates that the standard recovery was below the QC limit.
- "b" indicates that the standard recovery was above the QC limit.
- "c" indicates that the spike recovery was below the QC limit.
- "d" indicates that the spike recovery was above the QC limit.
- "e" indicates that the RPD was above the QC limit.
- "f" indicates that there was blank contamination.

In the analytical tables in this section, the "Mean" column is the average of the result and the duplicate values. All values, including those below the detection level (denoted by the less-than symbol, "<"), were averaged. If both the sample and duplicate values were non-detected, the mean is expressed as a non-detected value. If both the values were detected, the mean is expressed as a detected value.

B2.2 THERMODYNAMIC ANALYSES

As required by the safety screening and historical DQOs, TGA, and DSC were performed on the solids and liquids.

B2.2.1 Thermogravimetric Analysis

Thermogravimetric analysis measures the mass of a sample while its temperature is increased at a constant rate. Nitrogen is passed over the sample during heating to remove any released gases. Any decrease in the weight of a sample during TGA represents a loss of gaseous matter from the sample, either through evaporation or through a reaction that forms gas phase products. The moisture content is estimated by assuming that all TGA sample weight loss up to a certain temperature (150 to 200 °C [302 to 392 °F]) is due to water evaporation. The temperature limit for moisture loss is chosen by the operator at an inflection point on the TGA plot. Other volatile matter fractions can often be differentiated by inflection points as well.

The TGA analyses were performed in duplicate on direct subsamples. Results were determined by summing weight loss steps below 200 °C (392 °F); weight loss steps above this were not used to determine the result.

The field blank showed 100.0 percent water content. The TGA results are presented in Table B2-2.

B2.2.2 Differential Scanning Calorimetry

In a DSC analysis, heat absorbed or emitted by a substance is measured while the temperature of the sample is heated at a constant rate. Nitrogen is passed over the sample material to remove any gases being released. The onset temperature for an endothermic or exothermic event is determined graphically.

None of the subsamples submitted for DSC exceeded the notification limits as stated in the TSAP.

The DSC analyses were performed in duplicate on direct subsamples. The exothermic energy based on the dry weight of the subsample was calculated for all subsamples. The average of the TGA results for each subsample was used in the dry weight correction for that subsample.

The chemist noted that the thermogram for core 162, segment 3, upper half (sample number S96T004358) shows an inflection at approximately 300 °C (572 °F) that may indicate a change in the heat capacity of the sample.

Table B2-2. Tank 241-C-104 Analytical Results: Percent Water (TGA). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids			%	%	%
S96T004838	162: 1	Upper half	45.9	37.7	41.8
S96T004841		Lower half	40.5	53.7	47.1
S96T004839	162: 2	Upper half	51.4	44.7	48.0
S96T004842		Lower half	50.5	52.4	51.5
S96T004358	162: 3	Upper half	45.5	46.1	45.8
S96T004366		Lower half	47.5	52.9	50.2
S96T004363		Liquid	79.7	80.3	80.0
S96T004840	162: 4	Upper half	25.7	23.8	24.7
S96T004843		Lower half	20.8	19.0	19.9
S96T004843		Lower half	40.2	71.6	55.9[QC:e]
S96T004828		Liquid	81.2	82	81.6
S96T005360	165: 1	Lower half	38.7	38.7	38.7
S96T004371	165: 2	Upper half	50.6	46.0	48.3
S96T004379		Lower half	59.8	56.2	58.0

Table B2-2. Tank 241-C-104 Analytical Results: Percent Water (TGA). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
S96T004872	165: 3	Subsegment A Upper half	61.6	62	61.8
S96T004873		Subsegment B	59.0	72.0	65.5
S96T004874		Subsegment C	62.7	59.6	61.1
S96T004875	165: 4	Subsegment A Upper half	49.42	60.51	54.9
S96T004876		Subsegment B	61.57	61.21	61.3
S96T004877		Subsegment C	53.85	45.92	49.8
S96T004919	165: 5	Upper half	54.93	54.4	54.6
S96T004920	165: 5	Lower half	61.9	62.3	62.1
S96T004878	165: 6	Subsegment A Upper half	61.15	63.2	62.1
S96T004879		Subsegment B	58.77	58.79	58.7
S96T004880		Subsegment C	72.66	79.04	75.8
S96T004881		Subsegment D Lower half	80.59	81.07	80.8
S96T004947	Core 162	Solid composite	40.13	45.72	42.9
S96T004954	Core 165	Solid composite	53.36	52.4	52.8

The field blank resulted in 0.00 J/g. Non-zero DSC results are presented in Table B2-3.

Table B2-3. Tank 241-C-104 Analytical Results:
Exotherm - Transition 1 (DSC). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids			J/g	J/g	J/g
S96T004841	162: 1	Lower half	44.2	54.8	49.5
S96T004839	162: 2	Upper half	14.9	19.1	17
S96T004842		Lower half	54.3	23.8	39.0[QC:e]
S96T004366	162: 3	Lower half	40.4	34.7	37.5
S96T004363		Liquid	67	82	74.5
S96T004828	162: 4	Liquid	29.4	22.2	25.8

Table B2-3. Tank 241-C-104 Analytical Results:
Exotherm - Transition 1 (DSC). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
S96T004872	165: 3	Subsegment A Upper half	21.5	21.8	21.6
S96T004873		Subsegment B	29.3	36.1	32.7
S96T004876	165: 4	Subsegment B	18	33.2	25.6[QC:e]
S96T004877		Subsegment C	81.9	85.9	83.9
S96T004919	165: 5	Upper half	113	115	114
S96T004919		Upper half	113	181	147[QC:e]
S96T004878	165: 6	Subsegment A Upper half	40.9	22.8	31.8[QC:e]
S96T004879		Subsegment B	24.7	71.9	48.3[QC:e]

B2.3 PHYSICAL MEASUREMENTS

B2.3.1 Bulk Density

Bulk density analysis was performed for twelve of the twenty-three solid subsamples. As required by the TSAP, the analysis was only requested on lower half segments. Segments 3, 4, and 6 of core 165 was subsampled into "quarter segments" and the bulk density analysis was requested for the lower two quarter subsegments. The requested bulk density for core 165, segment 4, quarter segment C (sample number S96T004869) could not be performed because of insufficient sample.

The results of the bulk density test ranged from 1.42 to 1.97 g/mL. The highest bulk density of 1.97 g/mL was used to calculate the solid total alpha activity notification limit for this tank (31.2 μCi/g). The results of the bulk density measurements are provided in Table B2-4.

Table B2-4. Tank 241-C-104 Analytical Results: Bulk Density.

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Triplicate	Mean
Solids			g/mL	g/mL	g/mL	g/mL
S96T004835	162: 1	Lower half	1.76	NA	NA	1.76
S96T004836	162: 2	Lower half	1.71	NA	NA	1.71
S96T004365	162: 3	Lower half	1.56	NA	NA	1.56
S96T004837	162: 4	Lower half	1.97	NA	NA	1.97
S96T004375	165: 1	Lower half	1.73	NA	NA	1.73
S96T004376	165: 2	Lower half	1.76	NA	NA	1.76
S96T004866	165: 3	Subsegment B	1.96	NA	NA	1.96
S96T004867		Subsegment C	1.7	NA	NA	1.7
S96T004868	165: 4	Subsegment B	1.42	NA	NA	1.42
S96T004918	165: 5	Lower half	1.55	NA	NA	1.55
S96T004870	165: 6	Subsegment C	1.57	NA	NA	1.57
S96T004871		Subsegment D Lower half	1.57	NA	NA	1.57

Note:
NA = not analyzed

B2.3.2 Specific Gravity

Specific gravity analyses were performed on the liquid subsamples. Total alpha results for liquids do not require correction for density. The results of the specific gravity measurements are provided in Table B2-5.

Table B2-5. Tank 241-C-104 Analytical Results: Specific Gravity.

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids			unitless	unitless	unitless
S96T004363	162: 3	Liquid	1.14	1.13	1.14
S96T004828	162: 4	Liquid	1.08	1.09	1.09

B2.4 INORGANIC ANALYSES

B2.4.1 Total Organic Carbon

The TOC results are shown in Table B2-6. Sample S96T004877 exceeded the TOC programmatic notification limit of 30,000 μg/g. Eight TOC samples exceeded the 95 percent confidence interval upper limit for TOC of 3.00E+04 μg/g on a dry weight basis (Table C1-4). The mean of four of these samples also exceeded this limit on a dry weight basis (Table C1-4). A review of the percent water (Table C1-3) for these same samples indicates there is sufficient water to prevent a propagating reaction. The low DSC values (Table C1-2) associated with the relatively high TOC values in the solid samples indicates a majority of the measured carbon is no longer associated with compounds containing hydrogen and is, therefore, not reactive. As a result, the TOC is not a safety concern for tank 241-C-104.

Table B2-6. Tank 241-C-104 Analytical Results: Total Organic Carbon. (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids			μg/g	μg/g	μg/g
S96T004838	162: 1	Upper half	10,700	10,400	10,550
S96T004841		Lower half	10,900	10,100	10,500
S96T004839	162: 2	Upper half	19,100	20,100	19,600
S96T004842		Lower half	10,100	10,400	10,250
S96T004358	162: 3	Upper half	13,100	12,800	12,950
S96T004366		Lower half	12,400	11,800	12,100
S96T004840	162: 4	Upper half	1,870	1,580	1,725
S96T004843		Lower half	1,270	1,060	1,165
S96T005966	165: 1	Lower half	7,490	9,060	8,275
S96T004371	165: 2	Upper half	14,100	13,800	13,950
S96T004379		Lower half	8,430	10,100	9,265

Table B2-6. Tank 241-C-104 Analytical Results: Total Organic Carbon. (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids			μg/g	μg/g	μg/g
S96T004872	165: 3	Subsegment A Upper half	9,460	8,320	8,890
S96T004873		Subsegment B	10,400	9,720	10,060
S96T004874		Subsegment C	6,130	6,380	6,255
S96T004875	165: 4	Subsegment A Upper half	6,690	7,140	6,915
S96T004876		Subsegment B	9,110	8,290	8,700
S96T004877		Subsegment C	32,200	30,900	31,550
S96T004919	165: 5	Upper half	12,600	13,100	12,850
S96T004920		Lower half	15,100	16,500	15,800
S96T004878	165: 6	Subsegment A Upper half	4,940	5,110	5,025
S96T004879		Subsegment B	8,640	8,630	8,635
S96T004880		Subsegment C	2,320	2,680	2,500
S96T004881		Subsegment D Lower half	2,410	1,980	2,195[QC:c]
S96T004947	Core 162	Solid composite	7,790	8,220	8,005
S96T004954	Core 165	Solid composite	8,360	9,840	9,100
Liquids			μg/g	μg/g	μg/g
S96T004363	162: 3	Liquid	4,871	5,770	5,321[QC:f]
S96T004828	162: 4	Liquid	4,119	4,110	4,114[QC:f]

B2.4.2 Total Inorganic Carbon

Total inorganic carbon results are provided in Table B2-7.

Table B2-7. Tank 241-C-104 Analytical Results: Total Inorganic Carbon (TIC). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids			μg/g	μg/g	μg/g
S96T004838	162: 1	Upper half	9,110	8,720	8,915
S96T004841		Lower half	6,630	6,800	6,715
S96T004839	162: 2	Upper half	5,700	5,740	5,720
S96T004842		Lower half	5,490	5,460	5,475
S96T004358	162: 3	Upper half	5,380	5,380	5,380
S96T004366		Lower half	5,740	4,870	5,305
S96T004840	162: 4	Upper half	1,710	1,550	1,630[QC:d]
S96T004843		Lower half	1,630	1,600	1,615
S96T005966	165: 1	Lower half	15,800	17,300	16,550
S96T004371	165: 2	Upper half	18,100	16,000	17,050
S96T004379		Lower half	7,540	8,250	7,895
S96T004872	165: 3	Subsegment A Upper half	9,250	9,360	9,305
S96T004873		Subsegment B	7,600	8,100	7,850
S96T004874		Subsegment C	5,610	5,590	5,600
S96T004875	165: 4	Subsegment A Upper half	6,240	6,000	6,120
S96T004876		Subsegment B	5,600	5,160	5,380
S96T004877		Subsegment C	5,410	5,420	5,415
S96T004919	165: 5	Upper half	5,460	5,580	5,520
S96T004920		Lower half	7,850	8,130	7,990

Table B2-7. Tank 241-C-104 Analytical Results: Total Inorganic Carbon (TIC). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids			μg/g	μg/g	μg/g
S96T004878	165: 6	Subsegment A Upper half	5,500	6,140	5,820
S96T004879		Subsegment B	6,450	6,820	6,635
S96T004880		Subsegment C	2,930	2,600	2,765
S96T004881		Subsegment D Lower half	2,730	2,770	2,750
S96T004947	Core 162	Solid composite	4,390	4,910	4,650
S96T004954	Core 165	Solid composite	7,060	7,070	7,065
Liquids			μg/g	μg/g	μg/g
S96T004363	162: 3	Liquid	6,678	7,522	7,100[QC:f]
S96T004828	162: 4	Liquid	5,036	5,045	5,041[QC:f]

B2.4.3 Inductively Coupled Plasma

The concentrations of metals in the samples are shown in Tables B2-8 through B2-44. The results from three preparation methods, fusion, acid and water, are presented for the metals. Liquid results are included with solid fusion results, but the liquids underwent acid dilution, not fusion digestion.

An evaluation of the ICP data results in the following observations:

1. The presence of cadmium at the levels measured indicates its addition to the tank to control criticality (tank 241-C-104 has a significant inventory of Pu).

2. The presence of manganese at the levels measured in peculiar and may indicate the presence of permanganate in OWW waste or the addition of permanganate to SMMA1 waste.

3. The silicon level measured is suggestive of PUREX CWP waste.

4. The silver level measured is unusual. There is no current explanation for its presence at this level.

Table B2-8. Tank 241-C-104 Analytical Results: Aluminum (ICP). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid			μg/g	μg/g	μg/g
S96T004950	Core 162	Solid composite	69,300	68,100	68,700
S96T004957	Core 165	Solid composite	29,000	33,100	31,050
Solids: fusion			μg/g	μg/g	μg/g
S96T004850	162: 1	Upper half	15,700	13,100	14,400
S96T004853		Lower half	2,830	3,380	3,105
S96T004851	162: 2	Upper half	35,200	35,600	35,400
S96T004854		Lower half	9,720	11,300	10,510
S96T004360	162: 3	Upper half	26,500	26,300	26,400
S96T004368		Lower half	49,700	46,900	48,300
S96T004363		Liquid	1,220	1,229	1,224
S96T004852	162: 4	Upper half	2.020E+05	2.150E+05	2.085E+05[QC:d]
S96T004855		Lower half	1.910E+05	1.980E+05	1.945E+05
S96T004828		Liquid	1,137	1,137	1,137
S96T004380	165: 1	Lower half	22,700	23,400	23,050
S96T004373	165: 2	Upper half	33,300	34,700	34,000
S96T004381		Lower half	2,590	2,680	2,635
S96T004889	165: 3	Subsegment A Upper half	5,410	5,540	5,475
S96T004893		Subsegment B	18,700	19,700	19,200
S96T004894		Subsegment C	2,440	2,900	2,670

Table B2-8. Tank 241-C-104 Analytical Results: Aluminum (ICP). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			µg/g	µg/g	µg/g
S96T004890	165: 4	Subsegment A Upper half	3,450	3,440	3,445
S96T004895		Subsegment B	13,700	13,500	13,600
S96T004896		Subsegment C	31,600	29,600	30,600
S96T004923	165: 5	Upper half	12,600	12,000	12,300
S96T004924		Lower half	7,870	6,270	7,070
S96T004891	165: 6	Subsegment A Upper half	19,400	19,300	19,350
S96T004892		Subsegment B	46,400	78,000	62,200[QC:e]
S96T004897		Subsegment C	1.85E+05	1.97E+05	1.91E+05
S96T004898		Subsegment D Lower half	1.57E+05	1.56E+05	1.56E+05
S96T004949	Core 162	Solid composite	76,800	78,600	77,700
S96T004956	Core 165	Solid composite	31,500	30,800	31,150
Solids: water digest			µg/g	µg/g	µg/g
S96T004952	Core 162	Solid composite	682	688	685
S96T004959	Core 165	Solid composite	661	676	668

Table B2-9. Tank 241-C-104 Analytical Results: Antimony (ICP). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid			µg/g	µg/g	µg/g
S96T004950	Core 162	Solid composite	<11.7	<12.1	<11.9
S96T004957	Core 165	Solid composite	<23.7	<23.2	<23.4
Solids: fusion			µg/g	µg/g	µg/g
S96T004850	162: 1	Upper half	<1,230	1,370	<1,300
S96T004853		Lower half	<1,110	<1,120	<1,115
S96T004851	162: 2	Upper half	<1,260	<1,290	<1,275
S96T004854		Lower half	<1,350	<1,340	<1,345
S96T004360	162: 3	Upper half	<1,180	<1,220	<1,200
S96T004368		Lower half	<1,190	<1,220	<1,205
S96T004363		Liquid	<11.1	<11.1	<11.1
S96T004852	162: 4	Upper half	<1,090	<1,070	<1,080
S96T004855		Lower half	<1,120	<1,200	<1,160
S96T004828		Liquid	<11.1	<11.1	<11.1
S96T004380	165: 1	Lower half	<1,280	<1,350	<1,315
S96T004373	165: 2	Upper half	<1,230	<1,200	<1,215
S96T004381		Lower half	<1,330	<1,280	<1,305
S96T004889	165: 3	Subsegment A Upper half	<1,170	<1,150	<1,160
S96T004893		Subsegment B	<1,260	<1,260	<1,260
S96T004894		Subsegment C	<1,280	<1,300	<1,290
S96T004890	165: 4	Subsegment A Upper half	<1,170	<1,180	<1,175
S96T004895		Subsegment B	<1,290	<1,250	<1,270
S96T004896		Subsegment C	<1,290	<1,320	<1,305
S96T004923	165: 5	Upper half	<1,140	<1,090	<1,115
S96T004924		Lower half	<1,200	<1,210	<1,205

Table B2-9. Tank 241-C-104 Analytical Results: Antimony (ICP). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			µg/g	µg/g	µg/g
S96T004891	165: 6	Subsegment A Upper half	<1,240	<1,200	<1,220
S96T004892		Subsegment B	<1,140	<1,080	<1,110
S96T004897		Subsegment C	<1,110	<1,100	<1,105
S96T004898		Subsegment D Lower half	<1,190	<1,230	<1,210
S96T004949	Core 162	Solid composite	<1,300	<1,280	<1,290
S96T004956	Core 165	Solid composite	<1,330	<1,330	<1,330
Solids: water digest			µg/g	µg/g	µg/g
S96T004952	Core 162	Solid composite	<130	<128	<129
S96T004959	Core 165	Solid composite	<120	<120	<120

Table B2-10. Tank 241-C-104 Analytical Results: Arsenic (ICP). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid			µg/g	µg/g	µg/g
S96T004950	Core 162	Solid composite	<19.5	<20.1	<19.8
S96T004957	Core 165	Solid composite	<39.4	<38.6	<39
Solids: fusion			µg/g	µg/g	µg/g
S96T004850	162: 1	Upper half	<2,050	<2,020	<2,035
S96T004853		Lower half	<1,860	<1,870	<1,865
S96T004851	162: 2	Upper half	<2,100	<2,160	<2,130
S96T004854		Lower half	<2,250	<2,230	<2,240
S96T004360	162: 3	Upper half	<1,970	<2,040	<2,005
S96T004368		Lower half	<1,980	<2,040	<2,010
S96T004363		Liquid	<18.4	<18.4	<18.4

Table B2-10. Tank 241-C-104 Analytical Results: Arsenic (ICP). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			μg/g	μg/g	μg/g
S96T004852	162: 4	Upper half	<1,820	<1,790	<1,805
S96T004855		Lower half	<1,870	<2,000	<1,935
S96T004828		Liquid	<18.4	<18.4	<18.4
S96T004380	165: 1	Lower half	<2,140	<2,260	<2,200
S96T004373	165: 2	Upper half	<2,050	<2,000	<2,025
S96T004381		Lower half	<2,220	<2,140	<2,180
S96T004889	165: 3	Subsegment A Upper half	<1,940	<1,920	<1,930
S96T004893		Subsegment B	<2,090	<2,110	<2,100
S96T004894		Subsegment C	<2,140	<2,170	<2,155
S96T004890	165: 4	Subsegment A Upper half	<1,940	<1,970	<1,955
S96T004895		Subsegment B	<2,150	<2,080	<2,115
S96T004896		Subsegment C	<2,150	<2,210	<2,180
S96T004923	165: 5	Upper half	<1,900	<1,810	<1,855
S96T004924		Lower half	<2,000	<2,010	<2,005
S96T004891	165: 6	Subsegment A Upper half	<2,060	<2,000	<2,030
S96T004892		Subsegment B	<1,900	<1,800	<1,850
S96T004897		Subsegment C	<1,850	<1,830	<1,840
S96T004898		Subsegment D Lower half	<1,990	<2,050	<2,020
S96T004949	Core 162	Solid composite	<2,170	<2,130	<2,150
S96T004956	Core 165	Solid composite	<2,220	<2,220	<2,220
Solids: water digest			μg/g	μg/g	μg/g
S96T004952	Core 162	Solid composite	<217	<213	<215
S96T004959	Core 165	Solid composite	<200	<200	<200

Table B2-11. Tank 241-C-104 Analytical Results: Barium (ICP). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid			µg/g	µg/g	µg/g
S96T004950	Core 162	Solid composite	76.9	79.2	78
S96T004957	Core 165	Solid composite	101	98.3	99.6
Solids: fusion			µg/g	µg/g	µg/g
S96T004850	162: 1	Upper half	<1,030	<1,010	<1,020
S96T004853		Lower half	<929	<937	<933
S96T004851	162: 2	Upper half	<1,050	<1,080	<1,065
S96T004854		Lower half	<1,130	<1,110	<1,120
S96T004360	162: 3	Upper half	<987	<1,020	<1,003
S96T004368		Lower half	<988	<1,020	<1,004
S96T004363		Liquid	<9.26	<9.26	<9.26
S96T004852	162: 4	Upper half	<909	<893	<901
S96T004855		Lower half	<933	<998	<965
S96T004828		Liquid	<9.26	<9.26	<9.26
S96T004380	165: 1	Lower half	<1,070	<1,130	<1,100
S96T004373	165: 2	Upper half	<1,020	<1,000	<1,010
S96T004381		Lower half	<1,110	<1,070	<1,090
S96T004889	165: 3	Subsegment A Upper half	<972	<962	<967
S96T004893		Subsegment B	<1,050	<1,050	<1,050
S96T004894		Subsegment C	<1,070	<1,080	<1,075
S96T004890	165: 4	Subsegment A Upper half	<971	<987	<979
S96T004895		Subsegment B	<1,070	<1,040	<1,055
S96T004896		Subsegment C	<1,070	<1,100	<1,085
S96T004923	165: 5	Upper half	<949	<905	<927
S96T004924		Lower half	<1,000	<1,010	<1,005

Table B2-11. Tank 241-C-104 Analytical Results: Barium (ICP). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			μg/g	μg/g	μg/g
S96T004891	165: 6	Subsegment A Upper half	<1,030	<999	<1,014
S96T004892		Subsegment B	<951	<900	<925
S96T004897		Subsegment C	<927	<913	<920
S96T004898		Subsegment D Lower half	<996	<1,020	<1,008
S96T004949	Core 162	Solid composite	<1,090	<1,060	<1,075
S96T004956	Core 165	Solid composite	<1,110	<1,110	<1,110
Solids: water digest			μg/g	μg/g	μg/g
S96T004952	Core 162	Solid composite	<108	<107	<107
S96T004959	Core 165	Solid composite	<99.9	<99.9	<99.9

Table B2-12. Tank 241-C-104 Analytical Results: Beryllium (ICP). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid			μg/g	μg/g	μg/g
S96T004950	Core 162	Solid composite	15.2	15.6	15.4
S96T004957	Core 165	Solid composite	30.9	30.4	30.6
Solids: fusion			μg/g	μg/g	μg/g
S96T004850	162: 1	Upper half	<103	<101	<102
S96T004853		Lower half	<92.9	<93.7	<93.3
S96T004851	162: 2	Upper half	<105	<108	<106
S96T004854		Lower half	<113	<111	<112
S96T004360	162: 3	Upper half	113	103	108
S96T004368		Lower half	<98.8	<102	<100
S96T004363		Liquid	<0.92	<0.92	<0.92

Table B2-12. Tank 241-C-104 Analytical Results: Beryllium (ICP). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			µg/g	µg/g	µg/g
S96T004852	162: 4	Upper half	<90.9	<89.3	<90.1
S96T004855		Lower half	<93.3	<99.8	<96.5
S96T004828		Liquid	<0.92	<0.92	<0.92
S96T004380	165: 1	Lower half	<107	<113	<110
S96T004373	165: 2	Upper half	<102	<100	<101
S96T004381		Lower half	<111	<107	<109
S96T004889	165: 3	Subsegment A Upper half	<97.2	<96.2	<96.7
S96T004893		Subsegment B	<105	<105	<105
S96T004894		Subsegment C	<107	<108	<107
S96T004890	165: 4	Subsegment A Upper half	<97.1	<98.7	<97.9
S96T004895		Subsegment B	<107	<104	<105
S96T004896		Subsegment C	<107	<110	<108
S96T004923	165: 5	Upper half	<94.9	<90.5	<92.7
S96T004924		Lower half	<100	<101	<100
S96T004891	165: 6	Subsegment A Upper half	<103	<99.9	<101.4
S96T004892		Subsegment B	<95.1	<90	<92.5
S96T004897		Subsegment C	<92.7	<91.3	<92
S96T004898		Subsegment D Lower half	<99.6	<102	<100
S96T004949	Core 162	Solid composite	<109	<106	<107
S96T004956	Core 165	Solid composite	<111	<111	<111
Solids: water digest			µg/g	µg/g	µg/g
S96T004952	Core 162	Solid composite	<10.8	<10.7	<10.7
S96T004959	Core 165	Solid composite	<9.99	<9.99	<9.99

Table B2-13. Tank 241-C-104 Analytical Results: Bismuth (ICP). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids			µg/g	µg/g	µg/g
S96T004950	Core 162	Solid composite	<19.5	<20.1	<19.8
S96T004957	Core 165	Solid composite	<39.4	<38.6	<39
Solids: fusion			µg/g	µg/g	µg/g
S96T004850	162: 1	Upper half	<2,050	<2,020	<2,035
S96T004853		Lower half	<1,860	<1,870	<1,865
S96T004851	162: 2	Upper half	<2,100	<2,160	<2,130
S96T004854		Lower half	<2,250	<2,230	<2,240
S96T004360	162: 3	Upper half	<1,970	<2,040	<2,005
S96T004368		Lower half	<1,980	<2,040	<2,010
S96T004363		Liquid	<18.4	<18.4	<18.4
S96T004852	162: 4	Upper half	<1,820	<1,790	<1,805
S96T004855		Lower half	<1,870	<2,000	<1,935
S96T004828		Liquid	<18.4	<18.4	<18.4
S96T004380	165: 1	Lower half	<2,140	<2,260	<2,200
S96T004373	165: 2	Upper half	<2,050	<2,000	<2,025
S96T004381		Lower half	<2,220	<2,140	<2,180
S96T004889	165: 3	Subsegment A Upper half	<1,940	<1,920	<1,930
S96T004893		Subsegment B	<2,090	<2,110	<2,100
S96T004894		Subsegment C	<2,140	<2,170	<2,155
S96T004890	165: 4	Subsegment A Upper half	<1,940	<1,970	<1,955
S96T004895		Subsegment B	<2,150	<2,080	<2,115
S96T004896		Subsegment C	<2,150	<2,210	<2,180
S96T004923	165: 5	Upper half	<1,900	<1,810	<1,855
S96T004924		Lower half	<2,000	<2,010	<2,005

Table B2-13. Tank 241-C-104 Analytical Results: Bismuth (ICP). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			µg/g	µg/g	µg/g
S96T004891	165: 6	Subsegment A Upper half	<2,060	<2,000	<2,030
S96T004892		Subsegment B	<1,900	<1,800	<1,850
S96T004897		Subsegment C	<1,850	<1,830	<1,840
S96T004898		Subsegment D Lower half	<1,990	<2,050	<2,020
S96T004949	Core 162	Solid composite	<2,170	<2,130	<2,150[QC:e]
S96T004956	Core 165	Solid composite	<2,220	<2,220	<2,220
Solids: water digest			µg/g	µg/g	µg/g
S96T004952	Core 162	Solid composite	<217	<213	<215
S96T004959	Core 165	Solid composite	<200	<200	<200

Table B2-14. Tank 241-C-104 Analytical Results: Boron (ICP). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid			µg/g	µg/g	µg/g
S96T004950	Core 162	Solid composite	102	98.8	100
S96T004957	Core 165	Solid composite	120	135	127
Solids: fusion			µg/g	µg/g	µg/g
S96T004850	162: 1	Upper half	<1,030	<1,010	<1,020
S96T004853		Lower half	<929	<937	<933
S96T004851	162: 2	Upper half	<1,050	<1,080	<1,065
S96T004854		Lower half	<1,130	<1,110	<1,120
S96T004360	162: 3	Upper half	<987	<1,020	<1,003
S96T004368		Lower half	<988	<1,020	<1,004
S96T004363		Liquid	16.7	16.7	16.7

Table B2-14. Tank 241-C-104 Analytical Results: Boron (ICP). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			µg/g	µg/g	µg/g
S96T004852	162: 4	Upper half	<909	<893	<901
S96T004855		Lower half	<933	<998	<965
S96T004828		Liquid	9.26	<9.26	<9.26
S96T004380	165: 1	Lower half	<1,070	<1,130	<1,100
S96T004373	165: 2	Upper half	<1,020	<1,000	<1,010
S96T004381		Lower half	<1,110	<1,070	<1,090
S96T004889	165: 3	Subsegment A Upper half	<972	<962	<967
S96T004893		Subsegment B	<1,050	<1,050	<1,050
S96T004894		Subsegment C	<1,070	<1,080	<1,075
S96T004890	165: 4	Subsegment A Upper half	<971	<987	<979
S96T004895		Subsegment B	<1,070	<1,040	<1,055
S96T004896		Subsegment C	<1,070	<1,100	<1,085
S96T004923	165: 5	Upper half	<949	<905	<927
S96T004924		Lower half	<1,000	<1,010	<1,005
S96T004891	165: 6	Subsegment A Upper half	<1,030	<999	<1,014
S96T004892		Subsegment B	<951	<900	<925
S96T004897		Subsegment C	<927	<913	<920
S96T004898		Subsegment D Lower half	<996	<1,020	<1,008
S96T004949	Core 162	Solid composite	<1,090	<1,060	<1,075
S96T004956	Core 165	Solid composite	<1,110	<1,110	<1,110
Solids: water digest			µg/g	µg/g	µg/g
S96T004952	Core 162	Solid composite	1,220	1,470	1,345
S96T004959	Core 165	Solid composite	882	752	817

Table B2-15. Tank 241-C-104 Analytical Results: Cadmium (ICP). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid			µg/g	µg/g	µg/g
S96T004950	Core 162	Solid composite	324	332	328
S96T004957	Core 165	Solid composite	863	845	854
Solids: fusion			µg/g	µg/g	µg/g
S96T004850	162: 1	Upper half	598	668	633
S96T004853		Lower half	301	312	306
S96T004851	162: 2	Upper half	297	327	312
S96T004854		Lower half	410	462	436
S96T004360	162: 3	Upper half	743	699	721
S96T004368		Lower half	471	477	474
S96T004363		Liquid	5.44	5.76	5.60
S96T004852	162: 4	Upper half	<90.9	<89.3	<90.1
S96T004855		Lower half	<93.3	<99.8	<96.5
S96T004828		Liquid	8.58	8.39	8.49
S96T004380	165: 1	Lower half	268	301	284
S96T004373	165: 2	Upper half	229	215	222
S96T004381		Lower half	576	572	574
S96T004889	165: 3	Subsegment A Upper half	3,000	2,840	2,920
S96T004893		Subsegment B	6,090	6,160	6,125
S96T004894		Subsegment C	1,430	1,540	1,485
S96T004890	165: 4	Subsegment A Upper half	384	363	373
S96T004895		Subsegment B	<107	<104	<105
S96T004896		Subsegment C	192	180	186
S96T004923	165: 5	Upper half	551	582	566
S96T004924		Lower half	908	827	867

Table B2-15. Tank 241-C-104 Analytical Results: Cadmium (ICP). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			µg/g	µg/g	µg/g
S96T004891	165: 6	Subsegment A Upper half	<103	<99.9	<101
S96T004892		Subsegment B	264	225	244
S96T004897		Subsegment C	<92.7	<91.3	<92
S96T004898		Subsegment D Lower half	<99.6	<102	<100
S96T004949	Core 162	Solid composite	376	345	360
S96T004956	Core 165	Solid composite	896	861	878
Solids: water digest			µg/g	µg/g	µg/g
S96T004952	Core 162	Solid composite	12	12.5	12.2
S96T004959	Core 165	Solid composite	27.7	28.7	28.2

Table B2-16. Tank 241-C-104 Analytical Results: Calcium (ICP). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid			µg/g	µg/g	µg/g
S96T004950	Core 162	Solid composite	2,050	2,160	2,105
S96T004957	Core 165	Solid composite	1,500	1,500	1,500
Solids: fusion			µg/g	µg/g	µg/g
S96T004850	162: 1	Upper half	2,100	<2,020	<2,060
S96T004853		Lower half	<1,860	<1,870	<1,865
S96T004851	162: 2	Upper half	5,030	4,630	4,830
S96T004854		Lower half	3,370	3,370	3,370
S96T004360	162: 3	Upper half	4,790	4,680	4,735
S96T004368		Lower half	2,930	2,620	2,775
S96T004363		Liquid	<18.4	<18.4	<18.4

Table B2-16. Tank 241-C-104 Analytical Results: Calcium (ICP). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			µg/g	µg/g	µg/g
S96T004852	162: 4	Upper half	<1,820	<1,790	<1,805
S96T004855		Lower half	<1,870	<2,000	<1,935
S96T004828		Liquid	<18.4	<18.4	<18.4
S96T004380	165: 1	Lower half	<2,140	<2,260	<2,200
S96T004373	165: 2	Upper half	<2,050	<2,000	<2,025
S96T004381		Lower half	<2,220	<2,140	<2,180
S96T004889	165: 3	Subsegment A Upper half	<1,940	<1,920	<1,930
S96T004893		Subsegment B	4,030	3,750	3,890
S96T004894		Subsegment C	<2,140	<2,170	<2,155
S96T004890	165: 4	Subsegment A Upper half	<1,940	<1,970	<1,955
S96T004895		Subsegment B	<2,150	<2,080	<2,115
S96T004896		Subsegment C	<2,150	<2,210	<2,180
S96T004923	165: 5	Upper half	5,020	5,150	5,085
S96T004924		Lower half	2,060	<2,010	<2,035
S96T004891	165: 6	Subsegment A Upper half	<2,060	<2,000	<2,030
S96T004892		Subsegment B	<1,900	<1,800	<1,850
S96T004897		Subsegment C	<1,850	<1,830	<1,840
S96T004898		Subsegment D Lower half	<1,990	<2,050	<2,020
S96T004949	Core 162	Solid composite	<2,170	<2,130	<2,150
S96T004956	Core 165	Solid composite	<2,220	<2,220	<2,220
Solids: water digest			µg/g	µg/g	µg/g
S96T004952	Core 162	Solid composite	<217	<213	<215
S96T004959	Core 165	Solid composite	<200	<200	<200

Table B2-17. Tank 241-C-104 Analytical Results: Cerium (ICP). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid			µg/g	µg/g	µg/g
S96T004950	Core 162	Solid composite	33.5	34.1	33.8
S96T004957	Core 165	Solid composite	51.9	51.8	51.8
Solids: fusion			µg/g	µg/g	µg/g
S96T004850	162: 1	Upper half	<2,050	<2,020	<2,035
S96T004853		Lower half	<1,860	<1,870	<1,865
S96T004851	162: 2	Upper half	<2,100	<2,160	<2,130
S96T004854		Lower half	<2,250	<2,230	<2,240
S96T004360	162: 3	Upper half	<1,970	<2,040	<2,005
S96T004368		Lower half	<1,980	<2,040	<2,010
S96T004363		Liquid	<18.4	<18.4	<18.4
S96T004852	162: 4	Upper half	<1,820	<1,790	<1,805
S96T004855		Lower half	<1,870	<2,000	<1,935
S96T004828		Liquid	<18.4	<18.4	<18.4
S96T004380	165: 1	Lower half	<2,140	<2,260	<2,200
S96T004373	165: 2	Upper half	<2,050	<2,000	<2,025
S96T004381		Lower half	<2,220	<2,140	<2,180
S96T004889	165: 3	Subsegment A Upper half	<1,940	<1,920	<1,930
S96T004893		Subsegment B	<2,090	<2,110	<2,100
S96T004894		Subsegment C	<2,140	<2,170	<2,155
S96T004890	165: 4	Subsegment A Upper half	<1,940	<1,970	<1,955
S96T004895		Subsegment B	<2,150	<2,080	<2,115
S96T004896		Subsegment C	<2,150	<2,210	<2,180
S96T004923	165: 5	Upper half	<1,900	<1,810	<1,855
S96T004924		Lower half	<2,000	<2,010	<2,005

Table B2-17. Tank 241-C-104 Analytical Results: Cerium (ICP). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			µg/g	µg/g	µg/g
S96T004891	165: 6	Subsegment A Upper half	<2,060	<2,000	<2,030
S96T004892		Subsegment B	<1,900	<1,800	<1,850
S96T004897		Subsegment C	<1,850	<1,830	<1,840
S96T004898		Subsegment D Lower half	<1,990	<2,050	<2,020
S96T004949	Core 162	Solid composite	<2,170	<2,130	<2,150
S96T004956	Core 165	Solid composite	<2,220	<2,220	<2,220
Solids: water digest			µg/g	µg/g	µg/g
S96T004952	Core 162	Solid composite	<217	<213	<215
S96T004959	Core 165	Solid composite	<200	<200	<200

Table B2-18. Tank 241-C-104 Analytical Results: Chromium (ICP). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid			µg/g	µg/g	µg/g
S96T004950	Core 162	Solid composite	698	709	703
S96T004957	Core 165	Solid composite	936	915	925
Solids: fusion			µg/g	µg/g	µg/g
S96T004850	162: 1	Upper half	957	1,080	1,018
S96T004853		Lower half	203	241	222
S96T004851	162: 2	Upper half	787	603	695[QC:e]
S96T004854		Lower half	1,520	1,610	1,565

Table B2-18. Tank 241-C-104 Analytical Results: Chromium (ICP). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			µg/g	µg/g	µg/g
S96T004360	162: 3	Upper half	2,510	2,430	2,470
S96T004368		Lower half	982	881	931
S96T004363		Liquid	10	10	10
S96T004852	162: 4	Upper half	<182	<179	<180
S96T004855		Lower half	<187	<200	<193
S96T004828		Liquid	7.31	7.40	7.35
S96T004380	165: 1	Lower half	777	810	793
S96T004373	165: 2	Upper half	782	761	771
S96T004381		Lower half	377	362	369
S96T004889	165: 3	Subsegment A Upper half	1,480	1,350	1,415
S96T004893		Subsegment B	4,100	4,220	4,160
S96T004894		Subsegment C	530	581	555
S96T004890	165: 4	Subsegment A Upper half	212	212	212
S96T004895		Subsegment B	623	582	602
S96T004896		Subsegment C	1,880	1,870	1,875
S96T004923	165: 5	Upper half	2,410	2,370	2,390
S96T004924		Lower half	1,600	1,610	1,605
S96T004891	165: 6	Subsegment A Upper half	<206	<200	<203
S96T004892		Subsegment B	420	373	396
S96T004897		Subsegment C	<185	<183	<184
S96T004898		Subsegment D Lower half	<199	<205	<202
S96T004949	Core 162	Solid composite	834	834	834
S96T004956	Core 165	Solid composite	952	907	929
Solids: water digest			µg/g	µg/g	µg/g
S96T004952	Core 162	Solid composite	56.7	56.1	56.4
S96T004959	Core 165	Solid composite	93.4	93.3	93.3

Table B2-19. Tank 241-C-104 Analytical Results: Cobalt (ICP). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid			µg/g	µg/g	µg/g
S96T004950	Core 162	Solid composite	<3.9	<4.03	<3.96
S96T004957	Core 165	Solid composite	<7.89	<7.73	<7.81
Solids: fusion			µg/g	µg/g	µg/g
S96T004850	162: 1	Upper half	<410	<404	<407
S96T004853		Lower half	<371	<375	<373
S96T004851	162: 2	Upper half	<420	<431	<425
S96T004854		Lower half	<451	<446	<448
S96T004360	162: 3	Upper half	<395	<408	<401
S96T004368		Lower half	<395	<407	<401
S96T004363		Liquid	<3.68	<3.68	<3.68
S96T004852	162: 4	Upper half	<363	<357	<360
S96T004855		Lower half	<373	<399	<386
S96T004828		Liquid	<3.68	<3.68	<3.68
S96T004380	165: 1	Lower half	<428	<451	<439
S96T004373	165: 2	Upper half	<410	<401	<405
S96T004381		Lower half	<443	<428	<435
S96T004889	165: 3	Subsegment A Upper half	<389	<385	<387
S96T004893		Subsegment B	<418	<421	<419
S96T004894		Subsegment C	<428	<434	<431
S96T004890	165: 4	Subsegment A Upper half	<388	<395	<391
S96T004895		Subsegment B	<429	<417	<423
S96T004896		Subsegment C	<429	<441	<435

Table B2-19. Tank 241-C-104 Analytical Results: Cobalt (ICP). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			µg/g	µg/g	µg/g
S96T004923	165: 5	Upper half	<380	<362	<371
S96T004924		Lower half	<401	<403	<402
S96T004891	165: 6	Subsegment A Upper half	<412	<400	<406
S96T004892		Subsegment B	<380	<360	<370
S96T004897		Subsegment C	<371	<365	<368
S96T004898		Subsegment D Lower half	<398	<409	<403
S96T004949	Core 162	Solid composite	<435	<426	<430
S96T004956	Core 165	Solid composite	<443	<444	<443
Solids: water digest			µg/g	µg/g	µg/g
S96T004952	Core 162	Solid composite	<43.4	<42.7	<43.0
S96T004959	Core 165	Solid composite	<40	<40	<40

Table B2-20. Tank 241-C-104 Analytical Results: Copper (ICP). (3 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid			µg/g	µg/g	µg/g
S96T004950	Core 162	Solid composite	114	115	114
S96T004957	Core 165	Solid composite	44.7	49.4	47.0
Solids: fusion			µg/g	µg/g	µg/g
S96T004850	162: 1	Upper half	211	<202	<206
S96T004853		Lower half	<186	<187	<186

Table B2-20. Tank 241-C-104 Analytical Results: Copper (ICP). (3 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			µg/g	µg/g	µg/g
S96T004851	162: 2	Upper half	<210	<216	<213
S96T004854		Lower half	<225	<223	<224
S96T004360	162: 3	Upper half	385	370	377
S96T004368		Lower half	<198	<204	<201
S96T004363		Liquid	10.7	10.7	10.7
S96T004852	162: 4	Upper half	<182	5,950	<3,066[QC:e]
S96T004855		Lower half	<187	<200	<193
S96T004828		Liquid	10.7	10.6	10.6
S96T004380	165: 1	Lower half	<214	<226	<220
S96T004373	165: 2	Upper half	<205	<200	<202
S96T004381		Lower half	<222	<214	<218
S96T004889	165: 3	Subsegment A Upper half	<194	<192	<193
S96T004893		Subsegment B	<209	<211	<210
S96T004894		Subsegment C	<214	<217	<215
S96T004890	165: 4	Subsegment A Upper half	<194	<197	<195
S96T004895		Subsegment B	<215	<208	<211
S96T004896		Subsegment C	<215	<221	<218
S96T004923	165: 5	Upper half	<190	<181	<185
S96T004924		Lower half	<200	<201	<200

Table B2-20. Tank 241-C-104 Analytical Results: Copper (ICP). (3 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			µg/g	µg/g	µg/g
S96T004891	165: 6	Subsegment A Upper half	<206	<200	<203
S96T004892		Subsegment B	<190	<180	<185
S96T004897		Subsegment C	<185	<183	<184
S96T004898		Subsegment D Lower half	<199	<205	<202
S96T004949	Core 162	Solid composite	<217	<213	<215
S96T004956	Core 165	Solid composite	<222	<222	<222
Solids: water digest			µg/g	µg/g	µg/g
S96T004952	Core 162	Solid composite	<21.7	<21.3	<21.5
S96T004959	Core 165	Solid composite	<20	<20	<20

Table B2-21. Tank 241-C-104 Analytical Results: Iron (ICP). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid			µg/g	µg/g	µg/g
S96T004950	Core 162	Solid composite	14,100	14,400	14,250
S96T004957	Core 165	Solid composite	18,200	17,800	18,000
Solids: fusion			µg/g	µg/g	µg/g
S96T004850	162: 1	Upper half	43,400	29,900	36,650[QC:e]
S96T004853		Lower half	3,150	2,840	2,995
S96T004851	162: 2	Upper half	21,200	20,200	20,700
S96T004854		Lower half	42,000	41,000	41,500
S96T004360	162: 3	Upper half	21,300	20,900	21,100
S96T004368		Lower half	8,690	8,370	8,530
S96T004363		Liquid	<9.26	<9.26	<9.26

Table B2-21. Tank 241-C-104 Analytical Results: Iron (ICP). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			µg/g	µg/g	µg/g
S96T004852	162: 4	Upper half	1,480	1,110	1,295[QC:e]
S96T004855		Lower half	2,400	2,000	2,200
S96T004828		Liquid	<9.26	<9.26	<9.26
S96T004380	165: 1	Lower half	96,400	1.080E+05	1.022E+05
S96T004373	165: 2	Upper half	71,500	66,700	69,100
S96T004381		Lower half	5,230	5,370	5,300
S96T004889	165: 3	Subsegment A Upper half	8,030	7,810	7,920
S96T004893		Subsegment B	25,400	26,000	25,700
S96T004894		Subsegment C	2,450	2,430	2,440
S96T004890	165: 4	Subsegment A Upper half	1,380	1,290	1,335
S96T004895		Subsegment B	2,660	2,650	2,655
S96T004896		Subsegment C	14,700	13,700	14,200
S96T004923	165: 5	Upper half	50,000	50,300	50,150
S96T004924		Lower half	14,100	13,700	13,900
S96T004891	165: 6	Subsegment A Upper half	2,030	1,990	2,010
S96T004892		Subsegment B	5,790	5,340	5,565
S96T004897		Subsegment C	2,480	2,450	2,465
S96T004898		Subsegment D Lower half	3,050	2,990	3,020
S96T004949	Core 162	Solid composite	14,600	15,400	15,000
S96T004956	Core 165	Solid composite	18,400	18,200	18,300
Solids: water digest			µg/g	µg/g	µg/g
S96T004952	Core 162	Solid composite	<108	<107	<107
S96T004959	Core 165	Solid composite	<99.9	<99.9	<99.9

Table B2-22. Tank 241-C-104 Analytical Results: Lanthanum (ICP). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid			μg/g	μg/g	μg/g
S96T004950	Core 162	Solid composite	30.9	31.9	31.4
S96T004957	Core 165	Solid composite	28.3	26.4	27.3
Solids: fusion			μg/g	μg/g	μg/g
S96T004850	162: 1	Upper half	<1,030	<1,010	<1,020
S96T004853		Lower half	<929	<937	<933
S96T004851	162: 2	Upper half	<1,050	<1,080	<1,065
S96T004854		Lower half	<1,130	<1,110	<1,120
S96T004360	162: 3	Upper half	<987	<1,020	<1,003
S96T004368		Lower half	<988	<1,020	<1,004
S96T004363		Liquid	<9.26	<9.26	<9.26
S96T004852	162: 4	Upper half	<909	<893	<901
S96T004855		Lower half	<933	<998	<965
S96T004828		Liquid	<9.26	<9.26	<9.26
S96T004380	165: 1	Lower half	<1,070	<1,130	<1,100
S96T004373	165: 2	Upper half	<1,020	<1,000	<1,010
S96T004381		Lower half	<1,110	<1,070	<1,090
S96T004889	165: 3	Subsegment A Upper half	<972	<962	<967
S96T004893		Subsegment B	<1,050	<1,050	<1,050
S96T004894		Subsegment C	<1,070	<1,080	<1,075
S96T004890	165: 4	Subsegment A Upper half	<971	<987	<979
S96T004895		Subsegment B	<1,070	<1,040	<1,055
S96T004896		Subsegment C	<1,070	<1,100	<1,085
S96T004923	165: 5	Upper half	<949	<905	<927
S96T004924		Lower half	<1,000	<1,010	<1,005

Table B2-22. Tank 241-C-104 Analytical Results: Lanthanum (ICP). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			µg/g	µg/g	µg/g
S96T004891	165: 6	Subsegment A Upper half	<1,030	<999	<1,014
S96T004892		Subsegment B	<951	<900	<925
S96T004897		Subsegment C	<927	<913	<920
S96T004898		Subsegment D Lower half	<996	<1,020	<1,008
S96T004949	Core 162	Solid composite	<1,090	<1,060	<1,075
S96T004956	Core 165	Solid composite	<1,110	<1,110	<1,110
Solids: water digest			µg/g	µg/g	µg/g
S96T004952	Core 162	Solid composite	<108	<107	<107
S96T004959	Core 165	Solid composite	<99.9	<99.9	<99.9

Table B2-23. Tank 241-C-104 Analytical Results: Lead (ICP). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid			µg/g	µg/g	µg/g
S96T004950	Core 162	Solid composite	517	515	516
S96T004957	Core 165	Solid composite	503	486	494
Solids: fusion			µg/g	µg/g	µg/g
S96T004850	162: 1	Upper half	<2,050	<2,020	<2,035
S96T004853		Lower half	<1,860	<1,870	<1,865
S96T004851	162: 2	Upper half	<2,100	<2,160	<2,130
S96T004854		Lower half	<2,250	<2,230	<2,240
S96T004360	162: 3	Upper half	<1,970	<2,040	<2,005
S96T004368		Lower half	<1,980	<2,040	<2,010
S96T004363		Liquid	<18.4	<18.4	<18.4

Table B2-23. Tank 241-C-104 Analytical Results: Lead (ICP). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			µg/g	µg/g	µg/g
S96T004852	162: 4	Upper half	<1,820	<1,790	<1,805
S96T004855		Lower half	<1,870	<2,000	<1,935
S96T004828		Liquid	<18.4	<18.4	<18.4
S96T004380	165: 1	Lower half	<2,140	2,520	<2,330
S96T004373	165: 2	Upper half	<2,050	<2,000	<2,025
S96T004381		Lower half	<2,220	<2,140	<2,180
S96T004889	165: 3	Subsegment A Upper half	<1,940	<1,920	<1,930
S96T004893		Subsegment B	<2,090	<2,110	<2,100
S96T004894		Subsegment C	<2,140	<2,170	<2,155
S96T004890	165: 4	Subsegment A Upper half	<1,940	<1,970	<1,955
S96T004895		Subsegment B	<2,150	<2,080	<2,115
S96T004896		Subsegment C	<2,150	<2,210	<2,180
S96T004923	165: 5	Upper half	<1,900	<1,810	<1,855
S96T004924		Lower half	<2,000	<2,010	<2,005
S96T004891	165: 6	Subsegment A Upper half	<2,060	<2,000	<2,030
S96T004892		Subsegment B	<1,900	<1,800	<1,850
S96T004897		Subsegment C	<1,850	<1,830	<1,840
S96T004898		Subsegment D Lower half	<1,990	<2,050	<2,020
S96T004949	Core 162	Solid composite	<2,170	<2,130	<2,150
S96T004956	Core 165	Solid composite	<2,220	<2,220	<2,220
Solids: water digest			µg/g	µg/g	µg/g
S96T004952	Core 162	Solid composite	<217	<213	<215
S96T004959	Core 165	Solid composite	<200	<200	<200

Table B2-24. Tank 241-C-104 Analytical Results: Lithium (ICP). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid			µg/g	µg/g	µg/g
S96T004950	Core 162	Solid composite	3.51	3.29	3.4
S96T004957	Core 165	Solid composite	<3.94	<3.86	<3.9
Solids: fusion			µg/g	µg/g	µg/g
S96T004850	162: 1	Upper half	<205	<202	<203
S96T004853		Lower half	<186	<187	<186
S96T004851	162: 2	Upper half	<210	<216	<213
S96T004854		Lower half	<225	<223	<224
S96T004360	162: 3	Upper half	<197	<204	<200
S96T004368		Lower half	<198	<204	<201
S96T004363		Liquid	<1.84	<1.84	<1.84
S96T004852	162: 4	Upper half	<182	<179	<180
S96T004855		Lower half	<187	<200	<193
S96T004828		Liquid	<1.84	<1.84	<1.84
S96T004380	165: 1	Lower half	<214	<226	<220
S96T004373	165: 2	Upper half	<205	<200	<202
S96T004381		Lower half	<222	<214	<218
S96T004889	165: 3	Subsegment A Upper half	<194	<192	<193
S96T004893		Subsegment B	<209	<211	<210
S96T004894		Subsegment C	<214	<217	<215
S96T004890	165: 4	Subsegment A Upper half	<194	<197	<195
S96T004895		Subsegment B	<215	<208	<211
S96T004896		Subsegment C	<215	<221	<218

Table B2-24. Tank 241-C-104 Analytical Results: Lithium (ICP). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			µg/g	µg/g	µg/g
S96T004923	165: 5	Upper half	<190	<181	<185
S96T004924		Lower half	<200	<201	<200
S96T004891	165: 6	Subsegment A Upper half	<206	<200	<203
S96T004892		Subsegment B	<190	<180	<185
S96T004897		Subsegment C	<185	<183	<184
S96T004898		Subsegment D Lower half	<199	<205	<202
S96T004949	Core 162	Solid composite	<217	<213	<215
S96T004956	Core 165	Solid composite	<222	<222	<222
Solids: water digest			µg/g	µg/g	µg/g
S96T004952	Core 162	Solid composite	<21.7	<21.3	<21.5
S96T004959	Core 165	Solid composite	<20	<20	<20

Table B2-25. Tank 241-C-104 Analytical Results: Magnesium (ICP). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid			μg/g	μg/g	μg/g
S96T004950	Core 162	Solid composite	<19.5	<20.1	<19.8
S96T004957	Core 165	Solid composite	234	224	229
Solids: fusion			μg/g	μg/g	μg/g
S96T004850	162: 1	Upper half	<2,050	<2,020	<2,035
S96T004853		Lower half	<1,860	<1,870	<1,865
S96T004851	162: 2	Upper half	<2,100	<2,160	<2,130
S96T004854		Lower half	<2,250	<2,230	<2,240
S96T004360	162: 3	Upper half	<1,970	<2,040	<2,005
S96T004368		Lower half	<1,980	<2,040	<2,010
S96T004363		Liquid	<18.4	<18.4	<18.4
S96T004852	162: 4	Upper half	<1,820	<1,790	<1,805
S96T004855		Lower half	<1,870	<2,000	<1,935
S96T004828		Liquid	<18.4	<18.4	<18.4
S96T004380	165: 1	Lower half	<2,140	<2,260	<2,200
S96T004373	165: 2	Upper half	<2,050	<2,000	<2,025
S96T004381		Lower half	<2,220	<2,140	<2,180
S96T004889	165: 3	Subsegment A Upper half	<1,940	<1,920	<1,930
S96T004893		Subsegment B	<2,090	<2,110	<2,100
S96T004894		Subsegment C	<2,140	<2,170	<2,155
S96T004890	165: 4	Subsegment A Upper half	<1,940	<1,970	<1,955
S96T004895		Subsegment B	<2,150	<2,080	<2,115
S96T004896		Subsegment C	<2,150	<2,210	<2,180
S96T004923	165: 5	Upper half	<1,900	<1,810	<1,855
S96T004924		Lower half	<2,000	<2,010	<2,005

Table B2-25. Tank 241-C-104 Analytical Results: Magnesium (ICP). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			µg/g	µg/g	µg/g
S96T004891	165: 6	Subsegment A Upper half	<2,060	<2,000	<2,030
S96T004892		Subsegment B	<1,900	<1,800	<1,850
S96T004897		Subsegment C	<1,850	<1,830	<1,840
S96T004898		Subsegment D Lower half	<1,990	<2,050	<2,020
S96T004949	Core 162	Solid composite	<2,170	<2,130	<2,150
S96T004956	Core 165	Solid composite	<2,220	<2,220	<2,220
Solids: water digest			µg/g	µg/g	µg/g
S96T004952	Core 162	Solid composite	<217	<213	<215
S96T004959	Core 165	Solid composite	<200	<200	<200

Table B2-26. Tank 241-C-104 Analytical Results: Manganese (ICP). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid			µg/g	µg/g	µg/g
S96T004950	Core 162	Solid composite	4,810	4,910	4,860
S96T004957	Core 165	Solid composite	3,280	3,260	3,270
Solids: fusion			µg/g	µg/g	µg/g
S96T004850	162: 1	Upper half	3,740	3,460	3,600
S96T004853		Lower half	1,520	1,520	1,520
S96T004851	162: 2	Upper half	19,300	19,200	19,250
S96T004854		Lower half	4,750	5,010	4,880
S96T004360	162: 3	Upper half	8,110	8,010	8,060
S96T004368		Lower half	6,980	6,620	6,800
S96T004363		Liquid	<1.84	<1.84	<1.84

Table B2-26. Tank 241-C-104 Analytical Results: Manganese (ICP). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			μg/g	μg/g	μg/g
S96T004852	162: 4	Upper half	<182	<179	<180
S96T004855		Lower half	<187	<200	<193
S96T004828		Liquid	<1.84	<1.84	<1.84
S96T004380	165: 1	Lower half	6,230	6,780	6,505
S96T004373	165: 2	Upper half	2,330	2,030	2,180
S96T004381		Lower half	2,130	2,010	2,070
S96T004889	165: 3	Subsegment A Upper half	1,000	945	972
S96T004893		Subsegment B	3,000	3,160	3,080
S96T004894		Subsegment C	1,580	1,650	1,615
S96T004890	165: 4	Subsegment A Upper half	877	809	843
S96T004895		Subsegment B	2,130	2,080	2,105
S96T004896		Subsegment C	12,500	12,600	12,550
S96T004923	165: 5	Upper half	8,830	8,630	8,730
S96T004924		Lower half	8,760	8,130	8,445
S96T004891	165: 6	Subsegment A Upper half	744	742	743
S96T004892		Subsegment B	3,490	2,990	3,240
S96T004897		Subsegment C	642	616	629
S96T004898		Subsegment D Lower half	<199	<205	<202
S96T004949	Core 162	Solid composite	5,170	5,070	5,120
S96T004956	Core 165	Solid composite	3,360	3,340	3,350
Solids: water digest			μg/g	μg/g	μg/g
S96T004952	Core 162	Solid composite	<21.7	<21.3	<21.5
S96T004959	Core 165	Solid composite	<20	<20	<20

Table B2-27. Tank 241-C-104 Analytical Results: Molybdenum (ICP). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid			µg/g	µg/g	µg/g
S96T004950	Core 162	Solid composite	<9.75	<10.1	<9.92
S96T004957	Core 165	Solid composite	<19.7	<19.3	<19.5
Solids: fusion			µg/g	µg/g	µg/g
S96T004850	162: 1	Upper half	<1,030	<1,010	<1,020
S96T004853		Lower half	<929	<937	<933
S96T004851	162: 2	Upper half	<1,050	<1,080	<1,065
S96T004854		Lower half	<1,130	<1,110	<1,120
S96T004360	162: 3	Upper half	<987	<1,020	<1,003
S96T004368		Lower half	<988	<1,020	<1,004
S96T004363		Liquid	<9.26	<9.26	<9.26
S96T004852	162: 4	Upper half	<909	<893	<901
S96T004855		Lower half	<933	<998	<965
S96T004828		Liquid	<9.26	<9.26	<9.26
S96T004380	165: 1	Lower half	<1,070	<1,130	<1,100
S96T004373	165: 2	Upper half	<1,020	<1,000	<1,010
S96T004381		Lower half	<1,110	<1,070	<1,090
S96T004889	165: 3	Subsegment A Upper half	<972	<962	<967
S96T004893		Subsegment B	<1,050	<1,050	<1,050
S96T004894		Subsegment C	<1,070	<1,080	<1,075
S96T004890	165: 4	Subsegment A Upper half	<971	<987	<979
S96T004895		Subsegment B	<1,070	<1,040	<1,055
S96T004896		Subsegment C	<1,070	<1,100	<1,085
S96T004923	165: 5	Upper half	<949	<905	<927
S96T004924		Lower half	<1,000	<1,010	<1,005

Table B2-27. Tank 241-C-104 Analytical Results: Molybdenum (ICP). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			µg/g	µg/g	µg/g
S96T004891	165: 6	Subsegment A Upper half	<1,030	<999	<1,014
S96T004892		Subsegment B	<951	<900	<925
S96T004897		Subsegment C	<927	<913	<920
S96T004898		Subsegment D Lower half	<996	<1,020	<1,008
S96T004949	Core 162	Solid composite	<1,090	<1,060	<1,075
S96T004956	Core 165	Solid composite	<1,110	<1,110	<1,110
Solids: water digest			µg/g	µg/g	µg/g
S96T004952	Core 162	Solid composite	<108	<107	<107
S96T004959	Core 165	Solid composite	<99.9	<99.9	<99.9

Table B2-28. Tank 241-C-104 Analytical Results: Neodymium (ICP). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid			µg/g	µg/g	µg/g
S96T004950	Core 162	Solid composite	57.3	55.9	56.6
S96T004957	Core 165	Solid composite	73.4	71.5	72.45
Solids: fusion			µg/g	µg/g	µg/g
S96T004850	162: 1	Upper half	<2,050	<2,020	<2,035
S96T004853		Lower half	<1,860	<1,870	<1,865
S96T004851	162: 2	Upper half	<2,100	<2,160	<2,130
S96T004854		Lower half	<2,250	<2,230	<2,240
S96T004360	162: 3	Upper half	<1,970	<2,040	<2,005
S96T004368		Lower half	<1,980	<2,040	<2,010
S96T004363		Liquid	<18.4	<18.4	<18.4

Table B2-28. Tank 241-C-104 Analytical Results: Neodymium (ICP). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			µg/g	µg/g	µg/g
S96T004852	162: 4	Upper half	<1,820	<1,790	<1,805
S96T004855		Lower half	<1,870	<2,000	<1,935
S96T004828		Liquid	<18.4	<18.4	<18.4
S96T004380	165: 1	Lower half	<2,140	<2,260	<2,200
S96T004373	165: 2	Upper half	<2,050	<2,000	<2,025
S96T004381		Lower half	<2,220	<2,140	<2,180
S96T004889	165: 3	Subsegment A Upper half	<1,940	<1,920	<1,930
S96T004893		Subsegment B	<2,090	<2,110	<2,100
S96T004894		Subsegment C	<2,140	<2,170	<2,155
S96T004890	165: 4	Subsegment A Upper half	<1,940	<1,970	<1,955
S96T004895		Subsegment B	<2,150	<2,080	<2,115
S96T004896		Subsegment C	<2,150	<2,210	<2,180
S96T004923	165: 5	Upper half	<1,900	<1,810	<1,855
S96T004924		Lower half	<2,000	<2,010	<2,005
S96T004891	165: 6	Subsegment A Upper half	<2,060	<2,000	<2,030
S96T004892		Subsegment B	<1,900	<1,800	<1,850
S96T004897		Subsegment C	<1,850	<1,830	<1,840
S96T004898		Subsegment D Lower half	<1,990	<2,050	<2,020
S96T004949	Core 162	Solid composite	<2,170	<2,130	<2,150
S96T004956	Core 165	Solid composite	<2,220	<2,220	<2,220
Solids: water digest			µg/g	µg/g	µg/g
S96T004952	Core 162	Solid composite	<217	<213	<215
S96T004959	Core 165	Solid composite	<200	<200	<200

Table B2-29. Tank 241-C-104 Analytical Results: Nickel (ICP). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid			μg/g	μg/g	μg/g
S96T004950	Core 162	Solid composite	1,440	1,430	1,435
S96T004957	Core 165	Solid composite	1,760	1,730	1,745
Solids: water digest			μg/g	μg/g	μg/g
S96T004952	Core 162	Solid composite	130	129	129
S96T004959	Core 165	Solid composite	48.5	47.8	48.1

Table B2-30. Tank 241-C-104 Analytical Results: Phosphorus (ICP). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid			μg/g	μg/g	μg/g
S96T004950	Core 162	Solid composite	1,060	1,230	1,145
S96T004957	Core 165	Solid composite	88.4	149	118[QC:e]
Solids: fusion			μg/g	μg/g	μg/g
S96T004850	162: 1	Upper half	<4,100	<4,040	<4,070
S96T004853		Lower half	<3,710	<3,750	<3,730
S96T004851	162: 2	Upper half	<4,200	<4,310	<4,255
S96T004854		Lower half	4,730	5,350	5,040
S96T004360	162: 3	Upper half	5,090	5,570	5,330
S96T004368		Lower half	<3,950	<4,070	<4,010
S96T004363		Liquid	944	935	940
S96T004852	162: 4	Upper half	<3,630	<3,570	<3,600
S96T004855		Lower half	<3,730	<3,990	<3,860
S96T004828		Liquid	1,027	1,009	1,018
S96T004380	165: 1	Lower half	<4,280	<4,510	<4,395
S96T004373	165: 2	Upper half	4,400	4,200	4,300
S96T004381		Lower half	<4,430	<4,280	<4,355

Table B2-30. Tank 241-C-104 Analytical Results: Phosphorus (ICP). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			µg/g	µg/g	µg/g
S96T004889	165: 3	Subsegment A Upper half	<3,890	<3,850	<3,870
S96T004893		Subsegment B	<4,180	<4,210	<4,195
S96T004894		Subsegment C	<4,280	<4,340	<4,310
S96T004890	165: 4	Subsegment A Upper half	<3,880	<3,950	<3,915
S96T004895		Subsegment B	<4,290	<4,170	<4,230
S96T004896		Subsegment C	<4,290	<4,410	<4,350
S96T004923	165: 5	Upper half	4,310	4,150	4,230
S96T004924		Lower half	<4,010	<4,030	<4,020
S96T004891	165: 6	Subsegment A Upper half	<4,120	<4,000	<4,060
S96T004892		Subsegment B	<3,800	<3,600	<3,700
S96T004897		Subsegment C	<3,710	<3,650	<3,680
S96T004898		Subsegment D Lower half	<3,980	<4,090	<4,035
S96T004949	Core 162	Solid composite	<4,350	<4,260	<4,305
S96T004956	Core 165	Solid composite	<4,430	<4,440	<4,435
Solids: water digest			µg/g	µg/g	µg/g
S96T004952	Core 162	Solid composite	842	1,220	1,031[QC:e]
S96T004959	Core 165	Solid composite	1,030	1,000	1,015

Table B2-31. Tank 241-C-104 Analytical Results: Potassium (ICP). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid			µg/g	µg/g	µg/g
S96T004950	Core 162	Solid composite	1,270	458	864[QC:e]
S96T004957	Core 165	Solid composite	876	613	744[QC:e]
Solids: water digest			µg/g	µg/g	µg/g
S96T004952	Core 162	Solid composite	<1,080	<1,070	<1,075
S96T004959	Core 165	Solid composite	<999	<999	<999

Table B2-32. Tank 241-C-104 Analytical Results: Samarium (ICP). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid			µg/g	µg/g	µg/g
S96T004950	Core 162	Solid composite	<19.5	<20.1	<19.8
S96T004957	Core 165	Solid composite	<39.4	<38.6	<39
Solids: fusion			µg/g	µg/g	µg/g
S96T004850	162: 1	Upper half	<2,050	<2,020	<2,035
S96T004853		Lower half	<1,860	<1,870	<1,865
S96T004851	162: 2	Upper half	<2,100	<2,160	<2,130
S96T004854		Lower half	<2,250	<2,230	<2,240
S96T004360	162: 3	Upper half	<1,970	<2,040	<2,005
S96T004368		Lower half	<1,980	<2,040	<2,010
S96T004363		Liquid	<18.4	<18.4	<18.4
S96T004852	162: 4	Upper half	<1,820	<1,790	<1,805
S96T004855		Lower half	<1,870	<2,000	<1,935
S96T004828		Liquid	<18.4	<18.4	<18.4
S96T004380	165: 1	Lower half	<2,140	<2,260	<2,200
S96T004373	165: 2	Upper half	<2,050	<2,000	<2,025
S96T004381		Lower half	<2,220	<2,140	<2,180

Table B2-32. Tank 241-C-104 Analytical Results: Samarium (ICP). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			µg/g	µg/g	µg/g
S96T004889	165: 3	Subsegment A Upper half	<1,940	<1,920	<1,930
S96T004893		Subsegment B	<2,090	<2,110	<2,100
S96T004894		Subsegment C	<2,140	<2,170	<2,155
S96T004890	165: 4	Subsegment A Upper half	<1,940	<1,970	<1,955
S96T004895		Subsegment B	<2,150	<2,080	<2,115
S96T004896		Subsegment C	<2,150	<2,210	<2,180
S96T004923	165: 5	Upper half	<1,900	<1,810	<1,855
S96T004924		Lower half	<2,000	<2,010	<2,005
S96T004891	165: 6	Subsegment A Upper half	<2,060	<2,000	<2,030
S96T004892		Subsegment B	<1,900	<1,800	<1,850
S96T004897		Subsegment C	<1,850	<1,830	<1,840
S96T004898		Subsegment D Lower half	<1,990	<2,050	<2,020
S96T004949	Core 162	Solid composite	<2,170	<2,130	<2,150
S96T004956	Core 165	Solid composite	<2,220	<2,220	<2,220
Solids: water digest			µg/g	µg/g	µg/g
S96T004952	Core 162	Solid composite	<217	<213	<215
S96T004959	Core 165	Solid composite	<200	<200	<200

Table B2-33. Tank 241-C-104 Analytical Results: Selenium (ICP). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid			μg/g	μg/g	μg/g
S96T004950	Core 162	Solid composite	<19.5	<20.1	<19.8
S96T004957	Core 165	Solid composite	<39.4	<38.6	<39
Solids: fusion			μg/g	μg/g	μg/g
S96T004850	162: 1	Upper half	<2,050	<2,020	<2,035
S96T004853		Lower half	<1,860	<1,870	<1,865
S96T004851	162: 2	Upper half	<2,100	<2,160	<2,130
S96T004854		Lower half	<2,250	<2,230	<2,240
S96T004360	162: 3	Upper half	<1,970	<2,040	<2,005
S96T004368		Lower half	<1,980	<2,040	<2,010
S96T004363		Liquid	21.5	23.5	22.5
S96T004852	162: 4	Upper half	<1,820	<1,790	<1,805
S96T004855		Lower half	<1,870	<2,000	<1,935
S96T004828		Liquid	<18.4	20.3	<19.4
S96T004380	165: 1	Lower half	<2,140	<2,260	<2,200
S96T004373	165: 2	Upper half	<2,050	<2,000	<2,025
S96T004381		Lower half	<2,220	<2,140	<2,180
S96T004889	165: 3	Subsegment A Upper half	<1,940	<1,920	<1,930
S96T004893		Subsegment B	<2,090	<2,110	<2,100
S96T004894		Subsegment C	<2,140	<2,170	<2,155
S96T004890	165: 4	Subsegment A Upper half	<1,940	<1,970	<1,955
S96T004895		Subsegment B	<2,150	<2,080	<2,115
S96T004896		Subsegment C	<2,150	<2,210	<2,180
S96T004923	165: 5	Upper half	<1,900	<1,810	<1,855
S96T004924		Lower half	<2,000	<2,010	<2,005

Table B2-33. Tank 241-C-104 Analytical Results: Selenium (ICP). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			µg/g	µg/g	µg/g
S96T004891	165: 6	Subsegment A Upper half	<2,060	<2,000	<2,030
S96T004892		Subsegment B	<1,900	<1,800	<1,850
S96T004897		Subsegment C	<1,850	<1,830	<1,840
S96T004898		Subsegment D Lower half	<1,990	<2,050	<2,020
S96T004949	Core 162	Solid composite	<2,170	<2,130	<2,150
S96T004956	Core 165	Solid composite	<2,220	<2,220	<2,220
Solids: water digest			µg/g	µg/g	µg/g
S96T004952	Core 162	Solid composite	<217	<213	<215
S96T004959	Core 165	Solid composite	<200	<200	<200

Table B2-34. Tank 241-C-104 Analytical Results: Silicon (ICP). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid			µg/g	µg/g	µg/g
S96T004950	Core 162	Solid composite	5,260	4,630	4,945[QC:b]
S96T004957	Core 165	Solid composite	3,420	3,480	3,450[QC:b]
Solids: fusion			µg/g	µg/g	µg/g
S96T004850	162: 1	Upper half	5,880	4,310	5,095[QC:e]
S96T004853		Lower half	2,650	2,110	2,380[qc:e]
S96T004851	162: 2	Upper half	11,600	12,400	12,000
S96T004854		Lower half	1,720	1,860	1,790
S96T004360	162: 3	Upper half	3,230	3,340	3,285
S96T004368		Lower half	6,820	7,150	6,985
S96T004363		Liquid	167	184	176[QC:d]

Table B2-34. Tank 241-C-104 Analytical Results: Silicon (ICP). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			μg/g	μg/g	μg/g
S96T004852	162: 4	Upper half	11,800	7,570	9,685[QC:e]
S96T004855		Lower half	9,570	10,000	9,785
S96T004828		Liquid	74.4	81.7	78.0[QC:d]
S96T004380	165: 1	Lower half	22,900	22,100	22,500
S96T004373	165: 2	Upper half	12,500	10,500	11,500
S96T004381		Lower half	<1,110	<1,070	<1,090
S96T004889	165: 3	Subsegment A Upper half	1,250	1,250	1,250
S96T004893		Subsegment B	3,560	3,700	3,630
S96T004894		Subsegment C	<1,070	<1,080	<1,075
S96T004890	165: 4	Subsegment A Upper half	<971	<987	<979
S96T004895		Subsegment B	2,030	2,180	2,105
S96T004896		Subsegment C	18,200	17,300	17,750
S96T004923	165: 5	Upper half	3,560	3,730	3,645
S96T004924		Lower half	2,650	2,350	2,500
S96T004891	165: 6	Subsegment A Upper half	1,050	1,140	1,095
S96T004892		Subsegment B	3,540	2,890	3,215
S96T004897		Subsegment C	3,910	3,670	3,790
S96T004898		Subsegment D Lower half	12,500	11,800	12,150
S96T004949	Core 162	Solid composite	5,840	5,960	5,900
S96T004956	Core 165	Solid composite	4,100	3,960	4,030
Solids: water digest			μg/g	μg/g	μg/g
S96T004952	Core 162	Solid composite	8,370	9,110	8,740
S96T004959	Core 165	Solid composite	3,820	3,410	3,615

Table B2-35. Tank 241-C-104 Analytical Results: Silver (ICP). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid			µg/g	µg/g	µg/g
S96T004950	Core 162	Solid composite	197	210	203[QC:a]
S96T004957	Core 165	Solid composite	303	307	305
Solids: fusion			µg/g	µg/g	µg/g
S96T004850	162: 1	Upper half	482	464	473[QC:c]
S96T004853		Lower half	384	414	399
S96T004851	162: 2	Upper half	409	625	517[QC:e]
S96T004854		Lower half	268	399	333[QC:e]
S96T004360	162: 3	Upper half	752	384	568[QC:e]
S96T004368		Lower half	421	673	547[QC:a,e]
S96T004363		Liquid	5.09	5.12	5.11
S96T004852	162: 4	Upper half	<182	<179	<180
S96T004855		Lower half	<187	<200	<193
S96T004828		Liquid	5.04	4.83	4.94
S96T004380	165: 1	Lower half	347	534	440[QC:e]
S96T004373	165: 2	Upper half	753	456	604[QC:e]
S96T004381		Lower half	415	435	425
S96T004889	165: 3	Subsegment A Upper half	449	445	447
S96T004893		Subsegment B	<209	<211	<210
S96T004894		Subsegment C	406	449	427
S96T004890	165: 4	Subsegment A Upper half	339	330	334
S96T004895		Subsegment B	306	366	336
S96T004896		Subsegment C	367	317	342
S96T004923	165: 5	Upper half	396	434	415
S96T004924		Lower half	503	506	504

Table B2-35. Tank 241-C-104 Analytical Results: Silver (ICP). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			µg/g	µg/g	µg/g
S96T004891	165: 6	Subsegment A Upper half	362	366	364
S96T004892		Subsegment B	212	196	204
S96T004897		Subsegment C	<185	<183	<184
S96T004898		Subsegment D Lower half	<199	<205	<202
S96T004949	Core 162	Solid composite	626	671	648
S96T004956	Core 165	Solid composite	664	588	626
Solids: water digest			µg/g	µg/g	µg/g
S96T004952	Core 162	Solid composite	<21.7	<21.3	<21.5
S96T004959	Core 165	Solid composite	20	22.2	21.1

Table B2-36. Tank 241-C-104 Analytical Results: Sodium (ICP). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid			µg/g	µg/g	µg/g
S96T004950	Core 162	Solid composite	77,200	78,900	78,050
S96T004957	Core 165	Solid composite	71,700	71,700	71,700
Solids: fusion			µg/g	µg/g	µg/g
S96T004850	162: 1	Upper half	1.620E+05	1.650E+05	1.635E+05
S96T004853		Lower half	1.890E+05	1.770E+05	1.830E+05
S96T004851	162: 2	Upper half	97,100	1.010E+05	99,050
S96T004854		Lower half	83,300	80,500	81,900
S96T004360	162: 3	Upper half	88,300	88,400	88,350
S96T004368		Lower half	1.310E+05	1.200E+05	1.255E+05
S96T004363		Liquid	68,073	68,715	68,394[QC:d]

Table B2-36. Tank 241-C-104 Analytical Results: Sodium (ICP). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			µg/g	µg/g	µg/g
S96T004852	162: 4	Upper half	60,200	55,600	57,900
S96T004855		Lower half	54,500	61,100	57,800
S96T004828		Liquid	64,770	64,862	64,816[QC:d]
S96T004380	165: 1	Lower half	1.380E+05	1.400E+05	1.390E+05
S96T004373	165: 2	Upper half	1.260E+05	1.260E+05	1.260E+05
S96T004381		Lower half	1.250E+05	1.230E+05	1.240E+05
S96T004889	165: 3	Subsegment A Upper half	1.070E+05	1.080E+05	1.075E+05
S96T004893		Subsegment B	1.070E+05	1.090E+05	1.080E+05[QC:e]
S96T004894		Subsegment C	1.490E+05	1.470E+05	1.480E+05
S96T004890	165: 4	Subsegment A Upper half	1.320E+05	1.210E+05	1.265E+05
S96T004895		Subsegment B	95,200	93,100	94,150
S96T004896		Subsegment C	1.040E+05	98,500	1.013E+05
S96T004923	165: 5	Upper half	91,200	86,200	88,700
S96T004924		Lower half	1.030E+05	1.070E+05	1.050E+05
S96T004891	165: 6	Subsegment A Upper half	1.170E+05	1.060E+05	1.115E+05
S96T004892		Subsegment B	98,100	95,900	97,000
S96T004897		Subsegment C	72,800	70,700	71,750
S96T004898		Subsegment D Lower half	89,400	87,500	88,450
S96T004949	Core 162	Solid composite	1.080E+05	1.100E+05	1.090E+05
S96T004956	Core 165	Solid composite	1.050E+05	1.070E+05	1.060E+05
Solids: water digest			µg/g	µg/g	µg/g
S96T004952	Core 162	Solid composite	72,600	75,500	74,050[QC:e]
S96T004959	Core 165	Solid composite	69,500	69,500	69,500[QC:e]

Table B2-37. Tank 241-C-104 Analytical Results: Strontium (ICP). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid			µg/g	µg/g	µg/g
S96T004950	Core 162	Solid composite	57.4	50.6	54
S96T004957	Core 165	Solid composite	49.6	53.6	51.6
Solids: fusion			µg/g	µg/g	µg/g
S96T004850	162: 1	Upper half	<205	<202	<203
S96T004853		Lower half	<186	<187	<186
S96T004851	162: 2	Upper half	<210	<216	<213
S96T004854		Lower half	<225	<223	<224
S96T004360	162: 3	Upper half	<197	<204	<200
S96T004368		Lower half	<198	<204	<201
S96T004363		Liquid	<1.84	<1.84	<1.84
S96T004852	162: 4	Upper half	<182	<179	<180
S96T004855		Lower half	<187	<200	<193
S96T004828		Liquid	<1.84	<1.84	<1.84
S96T004380	165: 1	Lower half	<214	<226	<220
S96T004373	165: 2	Upper half	<205	<200	<202
S96T004381		Lower half	<222	<214	<218
S96T004889	165: 3	Subsegment A Upper half	<194	<192	<193
S96T004893		Subsegment B	<209	<211	<210
S96T004894		Subsegment C	<214	<217	<215
S96T004890	165: 4	Subsegment A Upper half	<194	<197	<195
S96T004895		Subsegment B	<215	<208	<211
S96T004896		Subsegment C	<215	<221	<218
S96T004923	165: 5	Upper half	<190	<181	<185
S96T004924		Lower half	<200	<201	<200

Table B2-37. Tank 241-C-104 Analytical Results: Strontium (ICP). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			µg/g	µg/g	µg/g
S96T004891	165: 6	Subsegment A Upper half	<206	<200	<203
S96T004892		Subsegment B	<190	<180	<185
S96T004897		Subsegment C	<185	<183	<184
S96T004898		Subsegment D Lower half	297	291	294
S96T004949	Core 162	Solid composite	<217	<213	<215
S96T004956	Core 165	Solid composite	<222	<222	<222
Solids: water digest			µg/g	µg/g	µg/g
S96T004952	Core 162	Solid composite	<21.7	<21.3	<21.5
S96T004959	Core 165	Solid composite	<20	<20	<20

Table B2-38. Tank 241-C-104 Analytical Results: Sulfur (ICP). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid			µg/g	µg/g	µg/g
S96T004950	Core 162	Solid composite	564	568	566
S96T004957	Core 165	Solid composite	820	800	810
Solids: fusion			µg/g	µg/g	µg/g
S96T004850	162: 1	Upper half	<2,050	<2,020	<2,035
S96T004853		Lower half	<1,860	<1,870	<1,865
S96T004851	162: 2	Upper half	<2,100	<2,160	<2,130
S96T004854		Lower half	<2,250	<2,230	<2,240
S96T004360	162: 3	Upper half	<1,970	<2,040	<2,005
S96T004368		Lower half	<1,980	<2,040	<2,010
S96T004363		Liquid	1,321	1,311	1,316

Table B2-38. Tank 241-C-104 Analytical Results: Sulfur (ICP). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			µg/g	µg/g	µg/g
S96T004852	162: 4	Upper half	<1,820	<1,790	<1,805
S96T004855		Lower half	<1,870	<2,000	<1,935
S96T004828		Liquid	1,293	1,275	1,284
S96T004380	165: 1	Lower half	<2,140	<2,260	<2,200
S96T004373	165: 2	Upper half	<2,050	<2,000	<2,025
S96T004381		Lower half	<2,220	<2,140	<2,180
S96T004889	165: 3	Subsegment A Upper half	<1,940	<1,920	<1,930
S96T004893		Subsegment B	<2,090	<2,110	<2,100
S96T004894		Subsegment C	<2,140	<2,170	<2,155
S96T004890	165: 4	Subsegment A Upper half	<1,940	<1,970	<1,955
S96T004895		Subsegment B	<2,150	<2,080	<2,115
S96T004896		Subsegment C	<2,150	<2,210	<2,180
S96T004923	165: 5	Upper half	<1,900	<1,810	<1,855
S96T004924		Lower half	<2,000	<2,010	<2,005
S96T004891	165: 6	Subsegment A Upper half	<2,060	<2,000	<2,030
S96T004892		Subsegment B	<1,900	<1,800	<1,850
S96T004897		Subsegment C	<1,850	<1,830	<1,840
S96T004898		Subsegment D Lower half	<1,990	<2,050	<2,020
S96T004949	Core 162	Solid composite	<2,170	<2,130	<2,150
S96T004956	Core 165	Solid composite	<2,220	<2,220	<2,220
Solids: water digest			µg/g	µg/g	µg/g
S96T004952	Core 162	Solid composite	580	619	599
S96T004959	Core 165	Solid composite	978	968	973

Table B2-39. Tank 241-C-104 Analytical Results: Thallium (ICP). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid			µg/g	µg/g	µg/g
S96T004950	Core 162	Solid composite	<39	<40.3	<39.6
S96T004957	Core 165	Solid composite	<78.9	<77.3	<78.1
Solids: fusion			µg/g	µg/g	µg/g
S96T004850	162: 1	Upper half	<4,100	<4,040	<4,070
S96T004853		Lower half	<3,710	<3,750	<3,730
S96T004851	162: 2	Upper half	<4,200	<4,310	<4,255
S96T004854		Lower half	<4,510	<4,460	<4,485
S96T004360	162: 3	Upper half	<3,950	<4,080	<4,015
S96T004368		Lower half	<3,950	<4,070	<4,010
S96T004363		Liquid	<36.8	<36.8	<36.8
S96T004852	162: 4	Upper half	<3,630	<3,570	<3,600
S96T004855		Lower half	<3,730	<3,990	<3,860
S96T004828		Liquid	<36.8	<36.8	<36.8
S96T004380	165: 1	Lower half	<4,280	<4,510	<4,395
S96T004373	165: 2	Upper half	<4,100	<4,010	<4,055
S96T004381		Lower half	<4,430	<4,280	<4,355
S96T004889	165: 3	Subsegment A Upper half	<3,890	<3,850	<3,870
S96T004893		Subsegment B	<4,180	<4,210	<4,195
S96T004894		Subsegment C	<4,280	<4,340	<4,310
S96T004890	165: 4	Subsegment A Upper half	<3,880	<3,950	<3,915
S96T004895		Subsegment B	<4,290	<4,170	<4,230
S96T004896		Subsegment C	<4,290	<4,410	<4,350
S96T004923	165: 5	Upper half	<3,800	<3,620	<3,710
S96T004924		Lower half	<4,010	<4,030	<4,020

Table B2-39. Tank 241-C-104 Analytical Results: Thallium (ICP). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			µg/g	µg/g	µg/g
S96T004891	165: 6	Subsegment A Upper half	<4,120	<4,000	<4,060
S96T004892		Subsegment B	<3,800	<3,600	<3,700
S96T004897		Subsegment C	<3,710	<3,650	<3,680
S96T004898		Subsegment D Lower half	<3,980	<4,090	<4,035
S96T004949	Core 162	Solid composite	<4,350	<4,260	<4,305
S96T004956	Core 165	Solid composite	<4,430	<4,440	<4,435
Solids: water digest			µg/g	µg/g	µg/g
S96T004952	Core 162	Solid composite	<434	<427	<430
S96T004959	Core 165	Solid composite	<400	<400	<400

Table B2-40. Tank 241-C-104 Analytical Results: Titanium (ICP). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid			µg/g	µg/g	µg/g
S96T004950	Core 162	Solid composite	64.9	58.5	61.7[QC:a]
S96T004957	Core 165	Solid composite	56.6	56.6	56.6[QC:a]
Solids: fusion			µg/g	µg/g	µg/g
S96T004850	162: 1	Upper half	<205	<202	<203
S96T004853		Lower half	<186	<187	<186
S96T004851	162: 2	Upper half	<210	<216	<213
S96T004854		Lower half	<225	<223	<224
S96T004360	162: 3	Upper half	<197	<204	<200
S96T004368		Lower half	<198	<204	<201
S96T004363		Liquid	<1.84	<1.84	<1.84

Table B2-40. Tank 241-C-104 Analytical Results: Titanium (ICP). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			μg/g	μg/g	μg/g
S96T004852	162: 4	Upper half	<182	<179	<180
S96T004855		Lower half	222	<200	<211
S96T004828		Liquid	<1.84	<1.84	<1.84
S96T004380	165: 1	Lower half	342	464	403[QC:e]
S96T004373	165: 2	Upper half	<205	<200	<202
S96T004381		Lower half	<222	<214	<218
S96T004889	165: 3	Subsegment A Upper half	<194	<192	<193
S96T004893		Subsegment B	<209	<211	<210
S96T004894		Subsegment C	<214	<217	<215
S96T004890	165: 4	Subsegment A Upper half	<194	<197	<195
S96T004895		Subsegment B	<215	<208	<211
S96T004896		Subsegment C	<215	<221	<218
S96T004923	165: 5	Upper half	<190	<181	<185
S96T004924		Lower half	<200	<201	<200
S96T004891	165: 6	Subsegment A Upper half	<206	<200	<203
S96T004892		Subsegment B	<190	<180	<185
S96T004897		Subsegment C	<185	<183	<184
S96T004898		Subsegment D Lower half	<199	<205	<202
S96T004949	Core 162	Solid composite	<217	<213	<215
S96T004956	Core 165	Solid composite	<222	<222	<222
Solids: water digest			μg/g	μg/g	μg/g
S96T004952	Core 162	Solid composite	<21.7	<21.3	<21.5
S96T004959	Core 165	Solid composite	<20	<20	<20

Table B2-41. Tank 241-C-104 Analytical Results: Total Uranium (ICP). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid			µg/g	µg/g	µg/g
S96T004950	Core 162	Solid composite	17,100	17,500	17,300
S96T004957	Core 165	Solid composite	15,200	15,000	15,100
Solids: fusion			µg/g	µg/g	µg/g
S96T004850	162: 1	Upper half	23,800	32,100	27,950[QC:e]
S96T004853		Lower half	26,400	27,700	27,050
S96T004851	162: 2	Upper half	53,100	54,300	53,700
S96T004854		Lower half	<11,300	<11,100	<11,200
S96T004360	162: 3	Upper half	11,500	12,000	11,750
S96T004368		Lower half	24,400	24,700	24,550
S96T004363		Liquid	<91.7	<91.7	<91.7
S96T004852	162: 4	Upper half	<9,090	<8,930	<9,010
S96T004855		Lower half	15,600	16,000	15,800
S96T004828		Liquid	<91.7	<91.7	<91.7
S96T004380	165: 1	Lower half	<10,700	<11,300	<11,000
S96T004373	165: 2	Upper half	<10,200	<10,000	<10,100
S96T004381		Lower half	15,700	15,000	15,350
S96T004889	165: 3	Subsegment A Upper half	38,300	35,800	37,050
S96T004893		Subsegment B	35,500	35,900	35,700
S96T004894		Subsegment C	35,600	36,900	36,250
S96T004890	165: 4	Subsegment A Upper half	<9,710	<9,870	<9,790
S96T004895		Subsegment B	<10,700	10,500	<10,600
S96T004896		Subsegment C	54,200	55,300	54,750
S96T004923	165: 5	Upper half	12,800	13,700	13,250
S96T004924		Lower half	10,200	10,200	10,200

Table B2-41. Tank 241-C-104 Analytical Results: Total Uranium (ICP). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			µg/g	µg/g	µg/g
S96T004891	165: 6	Subsegment A Upper half	<10,300	<9,990	<10,145
S96T004892		Subsegment B	<9,510	<9,000	<9,255
S96T004897		Subsegment C	<9,270	<9,130	<9,200
S96T004898		Subsegment D Lower half	34,700	33,200	33,950
S96T004949	Core 162	Solid composite	25,900	29,500	27,700
S96T004956	Core 165	Solid composite	38,600	35,700	37,150
Solids: water digest			µg/g	µg/g	µg/g
S96T004952	Core 162	Solid composite	<1,080	<1,070	<1,075
S96T004959	Core 165	Solid composite	<999	<999	<999

Table B2-42. Tank 241-C-104 Analytical Results: Vanadium (ICP). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid			µg/g	µg/g	µg/g
S96T004950	Core 162	Solid composite	13.1	13.6	13.3
S96T004957	Core 165	Solid composite	<19.7	<19.3	<19.5
Solids: fusion			µg/g	µg/g	µg/g
S96T004850	162: 1	Upper half	<1,030	<1,010	<1,020
S96T004853		Lower half	<929	<937	<933
S96T004851	162: 2	Upper half	<1,050	<1,080	<1,065
S96T004854		Lower half	<1,130	<1,110	<1,120
S96T004360	162: 3	Upper half	<987	<1,020	<1,003
S96T004368		Lower half	<988	<1,020	<1,004
S96T004363		Liquid	<9.26	<9.26	<9.26

Table B2-42. Tank 241-C-104 Analytical Results: Vanadium (ICP). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			μg/g	μg/g	μg/g
S96T004852	162: 4	Upper half	<909	<893	<901
S96T004855		Lower half	<933	<998	<965
S96T004828		Liquid	<9.26	<9.26	<9.26
S96T004380	165: 1	Lower half	<1,070	<1,130	<1,100
S96T004373	165: 2	Upper half	<1,020	<1,000	<1,010
S96T004381		Lower half	<1,110	<1,070	<1,090
S96T004889	165: 3	Subsegment A Upper half	<972	<962	<967
S96T004893		Subsegment B	<1,050	<1,050	<1,050
S96T004894		Subsegment C	<1,070	<1,080	<1,075
S96T004890	165: 4	Subsegment A Upper half	<971	<987	<979
S96T004895		Subsegment B	<1,070	<1,040	<1,055
S96T004896		Subsegment C	<1,070	<1,100	<1,085
S96T004923	165: 5	Upper half	<949	<905	<927
S96T004924		Lower half	<1,000	<1,010	<1,005
S96T004891	165: 6	Subsegment A Upper half	<1,030	<999	<1,014
S96T004892		Subsegment B	<951	<900	<925
S96T004897		Subsegment C	<927	<913	<920
S96T004898		Subsegment D Lower half	<996	<1,020	<1,008
S96T004949	Core 162	Solid composite	<1,090	<1,060	<1,075
S96T004956	Core 165	Solid composite	<1,110	<1,110	<1,110
Solids: water digest			μg/g	μg/g	μg/g
S96T004952	Core 162	Solid composite	<108	<107	<107
S96T004959	Core 165	Solid composite	<99.9	<99.9	<99.9

Table B2-43. Tank 241-C-104 Analytical Results: Zinc (ICP). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid			μg/g	μg/g	μg/g
S96T004950	Core 162	Solid composite	67	69	68
S96T004957	Core 165	Solid composite	53.2	61.6	57.4
Solids: fusion			μg/g	μg/g	μg/g
S96T004850	162: 1	Upper half	<205	539	<372[QC:e]
S96T004853		Lower half	200	558	379[QC:e]
S96T004851	162: 2	Upper half	250	257	253
S96T004854		Lower half	<225	<223	<224
S96T004360	162: 3	Upper half	517	395	456[QC:e]
S96T004368		Lower half	268	209	238[QC:e]
S96T004363		Liquid	12.7	12.7	12.7
S96T004852	162: 4	Upper half	<182	<179	<180
S96T004855		Lower half	<187	<200	<193
S96T004828		Liquid	10.1	10.4	10.3
S96T004380	165: 1	Lower half	<214	<226	<220
S96T004373	165: 2	Upper half	<205	<200	<202
S96T004381		Lower half	<222	<214	<218
S96T004889	165: 3	Subsegment A Upper half	<194	491	<342[QC:e]
S96T004893		Subsegment B	447	411	429
S96T004894		Subsegment C	280	232	256
S96T004890	165: 4	Subsegment A Upper half	<194	<197	<195
S96T004895		Subsegment B	<215	<208	<211
S96T004896		Subsegment C	<215	<221	<218
S96T004923	165: 5	Upper half	<190	<181	<185
S96T004924		Lower half	<200	<201	<200

Table B2-43. Tank 241-C-104 Analytical Results: Zinc (ICP). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			µg/g	µg/g	µg/g
S96T004891	165: 6	Subsegment A Upper half	<206	<200	<203
S96T004892		Subsegment B	<190	<180	<185
S96T004897		Subsegment C	<185	207	<196
S96T004898		Subsegment D Lower half	<199	<205	<202
S96T004949	Core 162	Solid composite	527	496	511
S96T004956	Core 165	Solid composite	1,170	<222	<696[QC:e]
Solids: water digest			µg/g	µg/g	µg/g
S96T004952	Core 162	Solid composite	96.7	<21.3	<59[QC:e]
S96T004959	Core 165	Solid composite	<20	<20	<20

Table B2-44. Tank 241-C-104 Analytical Results: Zirconium (ICP). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: acid			µg/g	µg/g	µg/g
S96T004950	Core 162	Solid composite	20,100	19,600	19,850
S96T004957	Core 165	Solid composite	49,500	46,100	47,800
Solids: fusion			µg/g	µg/g	µg/g
S96T004850	162: 1	Upper half	42,000	44,800	43,400
S96T004853		Lower half	64,900	64,800	64,850
S96T004851	162: 2	Upper half	3,130	2,910	3,020
S96T004854		Lower half	820	830	825
S96T004360	162: 3	Upper half	1,830	2,370	2,100[QC:e]
S96T004368		Lower half	32,500	31,200	31,850
S96T004363		Liquid	<1.84	<1.84	<1.84

Table B2-44. Tank 241-C-104 Analytical Results: Zirconium (ICP). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			µg/g	µg/g	µg/g
S96T004852	162: 4	Upper half	<182	<179	<180
S96T004855		Lower half	<187	<200	<193
S96T004828		Liquid	<1.84	<1.84	<1.84
S96T004380	165: 1	Lower half	13,900	13,900	13,900
S96T004373	165: 2	Upper half	8,080	7,290	7,685
S96T004381		Lower half	85,300	84,700	85,000
S96T004889	165: 3	Subsegment A Upper half	96,400	93,300	94,850
S96T004893		Subsegment B	22,600	23,400	23,000
S96T004894		Subsegment C	94,300	95,900	95,100
S96T004890	165: 4	Subsegment A Upper half	1.040E+05	96,400	1.002E+05
S96T004895		Subsegment B	95,700	94,000	94,850
S96T004896		Subsegment C	3,650	5,260	4,455[QC:e]
S96T004923	165: 5	Upper half	1,940	2,080	2,010
S96T004924		Lower half	54,900	53,600	54,250
S96T004891	165: 6	Subsegment A Upper half	1.030E+05	1.010E+05	1.020E+05
S96T004892		Subsegment B	43,700	39,300	41,500
S96T004897		Subsegment C	4,860	4,720	4,790
S96T004898		Subsegment D Lower half	260	220	240
S96T004949	Core 162	Solid composite	21,500	22,500	22,000
S96T004956	Core 165	Solid composite	57,400	55,300	56,350
Solids: water digest			µg/g	µg/g	µg/g
S96T004952	Core 162	Solid composite	198	188	193
S96T004959	Core 165	Solid composite	401	420	410.5

B2.4.4 Ion Chromatography

Ion chromatography results are provided in Tables B2-45 through B2-52.

Table B2-45. Tank 241-C-104 Analytical Results: Bromide (IC).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: water digest			µg/g	µg/g	µg/g
S96T004856	162: 1	Upper half	<1,089	<1,100	<1,094
S96T004857		Lower half	<1,055	<1,070	<1,062
S96T004858	162: 2	Upper half	<586	<595	<590
S96T004859		Lower half	<493	<484	<488
S96T004361	162: 3	Upper half	<498	<489	<493
S96T004369		Lower half	<574	<570	<572
S96T004363		Liquid	<243	<243	<243
S96T004860	162: 4	Upper half	<1,038	<988	<1,013
S96T004861		Lower half	<1,099	<1,010	<1,054
S96T004828		Liquid	<127	<127	<127
S96T005968	165: 1	Lower half	<755	<730	<742
S96T004374	165: 2	Upper half	<251	<258	<254
S96T004383		Lower half	<575	<565	<570
S96T004899	165: 3	Subsegment A Upper half	<1,066	<1,050	<1,058
S96T004900		Subsegment B	<656	<631	<643
S96T004901		Subsegment C	<1,232	<1,240	<1,236
S96T004902	165: 4	Subsegment A Upper half	<508	<498	<503
S96T004903		Subsegment B	<293	<289	<291
S96T004904		Subsegment C	<258	<260	<259
S96T004925	165: 5	Upper half	<1,076	<1,030	<1,053
S96T004926		Lower half	<1,018	<993	<1,005
S96T004905	165: 6	Subsegment A Upper half	<280	<257	<268
S96T004906		Subsegment B	<281	<291	<286
S96T004907		Subsegment C	<114	<112	<113
S96T004908		Subsegment D Lower half	<264	<247	<255
S96T004951	Core 162	Solid composite	<554	<546	<550
S96T004958	Core 165	Solid composite	<997	<997	<997

Table B2-46. Tank 241-C-104 Analytical Results: Chloride (IC).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: water digest			µg/g	µg/g	µg/g
S96T004856	162: 1	Upper half	383	374	378
S96T004857		Lower half	327	724	525[QC:e]
S96T004858	162: 2	Upper half	448	909	678[QC:e]
S96T004859		Lower half	514	541	527
S96T004361	162: 3	Upper half	472	570	521
S96T004369		Lower half	421	483	452
S96T004363		Liquid	827	800	814
S96T004860	162: 4	Upper half	329	332	330[QC:d]
S96T004861		Lower half	318	270	294
S96T004828		Liquid	1,611	1,385	1,498
S96T005968	165: 1	Lower half	226	449	337[QC:e]
S96T004374	165: 2	Upper half	429	472	450
S96T004383		Lower half	494	663	578
S96T004899	165: 3	Subsegment A Upper half	695	747	721
S96T004900		Subsegment B	512	546	529
S96T004901		Subsegment C	611	637	624
S96T004902	165: 4	Subsegment A Upper half	471	507	489
S96T004903		Subsegment B	691	676	683
S96T004904		Subsegment C	507	428	467
S96T004925	165: 5	Upper half	371	413	392
S96T004926		Lower half	529	485	507
S96T004905	165: 6	Subsegment A Upper half	719	601	660
S96T004906		Subsegment B	652	686	669
S96T004907		Subsegment C	334	329	331
S96T004908		Subsegment D Lower half	391	377	384
S96T004951	Core 162	Solid composite	220	214	217
S96T004958	Core 165	Solid composite	417	1,080	748[QC:e]

Table B2-47. Tank 241-C-104 Analytical Results: Fluoride (IC).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: water digest			µg/g	µg/g	µg/g
S96T004856	162: 1	Upper half	65,830	64,300	65,065[QC:c]
S96T004857		Lower half	68,260	70,100	69,180
S96T004858	162: 2	Upper half	4,478	4,430	4,454
S96T004859		Lower half	5,508	4,880	5,194[QC:d]
S96T004361	162: 3	Upper half	4,836	4,680	4,758
S96T004369		Lower half	34,130	34,300	34,215
S96T004363		Liquid	5,988	5,926	5,957
S96T004860	162: 4	Upper half	1,419	1,500	1,459
S96T004861		Lower half	1,332	1,270	1,301
S96T004828		Liquid	9,275	8,963	9,119[QC:e]
S96T005968	165: 1	Lower half	9,407	9,030	9,218
S96T004374	165: 2	Upper half	6,068	3,660	4,864[QC:e]
S96T004383		Lower half	16,280	20,000	18,140
S96T004899	165: 3	Subsegment A Upper half	5,443	5,330	5,386
S96T004900		Subsegment B	11,800	11,700	11,750
S96T004901		Subsegment C	49,790	49,900	49,845
S96T004902	165: 4	Subsegment A Upper half	26,760	32,500	29,630[QC:d]
S96T004903		Subsegment B	5,889	5,770	5,829
S96T004904		Subsegment C	4,030	3,400	3,715
S96T004925	165: 5	Upper half	2,954	2,830	2,892
S96T004926		Lower half	2,831	3,030	2,930
S96T004905	165: 6	Subsegment A Upper half	2,961	2,430	2,695
S96T004906		Subsegment B	2,524	2,630	2,577
S96T004907		Subsegment C	1,418	1,410	1,414
S96T004908		Subsegment D Lower half	1,154	1,030	1,092
S96T004951	Core 162	Solid composite	27,250	27,900	27,575
S96T004958	Core 165	Solid composite	14,200	14,200	14,200[QC:c]

Table B2-48. Tank 241-C-104 Analytical Results: Nitrate (IC).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: water digest			µg/g	µg/g	µg/g
S96T004856	162: 1	Upper half	<1,211	7,130	<4,170[QC:e]
S96T004857		Lower half	<1,174	2,320	<1,747[QC:e]
S96T004858	162: 2	Upper half	9,065	8,750	8,907
S96T004859		Lower half	11,160	9,880	10,520
S96T004361	162: 3	Upper half	10,050	9,850	9,950
S96T004369		Lower half	12,810	12,800	12,805
S96T004363		Liquid	22,834	22,568	22,701
S96T004860	162: 4	Upper half	9,958	9,780	9,869
S96T004861		Lower half	11,550	11,300	11,425
S96T004828		Liquid	55,247	47,156	51,201[QC:c]
S96T005968	165: 1	Lower half	7,604	7,940	7,772
S96T004374	165: 2	Upper half	9,956	10,600	10,278
S96T004383		Lower half	11,940	14,400	13,170
S96T004899	165: 3	Subsegment A Upper half	18,380	18,400	18,390
S96T004900		Subsegment B	13,280	16,100	14,690
S96T004901		Subsegment C	18,070	17,800	17,935
S96T004902	165: 4	Subsegment A Upper half	14,540	16,300	15,420
S96T004903		Subsegment B	18,670	18,100	18,385
S96T004904		Subsegment C	15,040	12,900	13,970
S96T004925	165: 5	Upper half	15,110	14,800	14,955
S96T004926		Lower half	17,340	16,900	17,120
S96T004905	165: 6	Subsegment A Upper half	18,740	15,600	17,170
S96T004906		Subsegment B	17,500	18,100	17,800
S96T004907		Subsegment C	9,454	9,110	9,282[QC:d]
S96T004908		Subsegment D Lower half	11,640	10,800	11,220
S96T004951	Core 162	Solid composite	8,309	8,230	8,269
S96T004958	Core 165	Solid composite	15,520	15,200	15,360

Table B2-49. Tank 241-C-104 Analytical Results: Nitrite (IC).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: water digest			µg/g	µg/g	µg/g
S96T004856	162: 1	Upper half	22,710	21,700	22,205
S96T004857		Lower half	20,080	22,400	21,240
S96T004858	162: 2	Upper half	16,820	17,100	16,960
S96T004859		Lower half	20,970	18,400	19,685
S96T004361	162: 3	Upper half	15,320	15,400	15,360
S96T004369		Lower half	17,840	18,600	18,220
S96T004363		Liquid	32,100	31,743	31,922
S96T004860	162: 4	Upper half	9,730	9,470	9,600
S96T004861		Lower half	10,660	10,200	10,430
S96T004828		Liquid	58,284	48,899	53,591
S96T005968	165: 1	Lower half	28,350	30,800	29,575
S96T004374	165: 2	Upper half	30,080	32,800	31,440
S96T004383		Lower half	26,180	31,000	28,590
S96T004899	165: 3	Subsegment A Upper half	34,510	34,500	34,505
S96T004900		Subsegment B	22,300	28,200	25,250
S96T004901		Subsegment C	27,660	27,900	27,780
S96T004902	165: 4	Subsegment A Upper half	22,470	25,500	23,985
S96T004903		Subsegment B	28,720	28,600	28,660
S96T004904		Subsegment C	23,290	19,600	21,445
S96T004925	165: 5	Upper half	23,270	23,200	23,235
S96T004926		Lower half	27,490	27,000	27,245
S96T004905	165: 6	Subsegment A Upper half	30,440	25,100	27,770
S96T004906		Subsegment B	27,290	28,400	27,845
S96T004907		Subsegment C	13,960	14,000	13,980
S96T004908		Subsegment D Lower half	16,240	15,000	15,620
S96T004951	Core 162	Solid composite	15,980	16,300	16,140
S96T004958	Core 165	Solid composite	27,900	28,000	27,950

Table B2-50. Tank 241-C-104 Analytical Results: Phosphate (IC).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: water digest			μg/g	μg/g	μg/g
S96T004856	162: 1	Upper half	<1,046	<1,050	<1,048
S96T004857		Lower half	<1,013	4,080	<2,546[QC:e]
S96T004858	162: 2	Upper half	3,118	3,680	3,399
S96T004859		Lower half	2,947	2,280	2,613[QC:e]
S96T004361	162: 3	Upper half	2,182	1,560	1,871[QC:e]
S96T004369		Lower half	1,662	2,540	2,101[QC:e]
S96T004363		Liquid	1,668	1,697	1,683
S96T004860	162: 4	Upper half	2,136	2,080	2,108
S96T004861		Lower half	<1,055	1,870	<1,462[QC:e]
S96T004828		Liquid	5,108	6,110	5,609
S96T005968	165: 1	Lower half	3,207	2,900	3,053
S96T004374	165: 2	Upper half	2,046	2,160	2,103
S96T004383		Lower half	1,196	1,710	1,453[QC:e]
S96T004899	165: 3	Subsegment A Upper half	<1,023	<1,000	<1,011
S96T004900		Subsegment B	<629	1,430	<1,029[QC:e]
S96T004901		Subsegment C	<1,183	<1,190	<1,186
S96T004902	165: 4	Subsegment A Upper half	912	1,340	1,126[QC:e]
S96T004903		Subsegment B	2,105	1,900	2,002
S96T004904		Subsegment C	2,841	2,280	2,560
S96T004925	165: 5	Upper half	2,157	2,170	2,163
S96T004926		Lower half	3,212	6,580	4,896[QC:e]
S96T004905	165: 6	Subsegment A Upper half	2,954	2,520	2,737
S96T004906		Subsegment B	2,850	2,750	2,800
S96T004907		Subsegment C	3,415	3,290	3,352
S96T004908		Subsegment D Lower half	3,125	3,000	3,062
S96T004951	Core 162	Solid composite	2,268	2,880	2,574[QC:e]
S96T004958	Core 165	Solid composite	2,431	2,260	2,345

Table B2-51. Tank 241-C-104 Analytical Results: Sulfate (IC).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: water digest			µg/g	µg/g	µg/g
S96T004856	162: 1	Upper half	2,594	2,680	2,637
S96T004857		Lower half	2,389	5,740	4,064[QC:e]
S96T004858	162: 2	Upper half	2,131	2,640	2,385[QC:e]
S96T004859		Lower half	2,925	2,570	2,747
S96T004361	162: 3	Upper half	2,124	2,330	2,227
S96T004369		Lower half	2,596	2,670	2,633
S96T004363		Liquid	3,467	3,513	3,490
S96T004860	162: 4	Upper half	1,707	1,520	1,613
S96T004861		Lower half	1,758	1,740	1,749
S96T004828		Liquid	7,623	7,577	7,600
S96T005968	165: 1	Lower half	4,071	4,560	4,315
S96T004374	165: 2	Upper half	3,296	3,490	3,393
S96T004383		Lower half	2,435	3,170	2,802
S96T004899	165: 3	Subsegment A Upper half	3,297	3,540	3,418
S96T004900		Subsegment B	3,399	3,640	3,519
S96T004901		Subsegment C	3,589	3,520	3,554
S96T004902	165: 4	Subsegment A Upper half	2,987	3,440	3,213
S96T004903		Subsegment B	2,875	2,890	2,882
S96T004904		Subsegment C	2,054	1,770	1,912
S96T004925	165: 5	Upper half	3,107	2,830	2,968
S96T004926		Lower half	3,334	3,390	3,362
S96T004905	165: 6	Subsegment A Upper half	2,682	2,250	2,466
S96T004906		Subsegment B	2,406	2,510	2,458
S96T004907		Subsegment C	1,210	1,210	1,210
S96T004908		Subsegment D Lower half	1,364	1,380	1,372
S96T004951	Core 162	Solid composite	1,990	2,080	2,035
S96T004958	Core 165	Solid composite	3,218	3,550	3,384

Table B2-52. Tank 241-C-104 Analytical Results: Oxalate (IC).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: water digest			µg/g	µg/g	µg/g
S96T004856	162: 1	Upper half	5,192	13,900	9,546[QC:e]
S96T004857		Lower half	1,766	5,180	3,473[QC:e]
S96T004858	162: 2	Upper half	3,879	2,340	3,109[QC:e]
S96T004859		Lower half	3,058	5,390	4,224[QC:e]
S96T004361	162: 3	Upper half	17,520	24,800	21,160[QC:e]
S96T004369		Lower half	12,750	12,400	12,575
S96T004363		Liquid	2,308	2,284	2,296
S96T004860	162: 4	Upper half	1,544	1,640	1,592
S96T004861		Lower half	1,275	1,020	1,147[QC:e]
S96T004828		Liquid	1,910	1,862	1,886
S96T005968	165: 1	Lower half	49,500	4,800	27,150[QC:e]
S96T004374	165: 2	Upper half	1,408	2,800	2,104[QC:e]
S96T004383		Lower half	1,015	1,570	1,292[QC:e]
S96T004899	165: 3	Subsegment A Upper half	2,538	2,170	2,354
S96T004900		Subsegment B	18,120	71,900	45,010[QC:e]
S96T004901		Subsegment C	2,335	2,230	2,282
S96T004902	165: 4	Subsegment A Upper half	1,400	1,990	1,695[QC:e]
S96T004903		Subsegment B	2,486	2,450	2,468
S96T004904		Subsegment C	1,658	1,720	1,689
S96T004925	165: 5	Upper half	4,903	10,300	7,601[QC:e]
S96T004926		Lower half	3,183	2,990	3,086
S96T004905	165: 6	Subsegment A Upper half	1,964	1,630	1,797
S96T004906		Subsegment B	1,724	1,640	1,682
S96T004907		Subsegment C	922	899	910
S96T004908		Subsegment D Lower half	985	857	921
S96T004951	Core 162	Solid composite	4,285	3,890	4,087
S96T004958	Core 165	Solid composite	2,818	2,560	2,689

B2.5 RADIOCHEMICAL ANALYSES

B2.5.1 Total Alpha Activity (AT)

The liquid total alpha results were below the total alpha activity notification limit of 61.5 µCi/mL. For solid samples, the notification limit of 31.2 µCi/g (based on a bulk density of 1.97 g/mL) was exceeded for core 165, segment 3, quarter segment B (sample number S96T004893). Secondary analyses as described by the TSAP and directed by the tank coordinator were performed for this sample. Those analyses indicate the vast majority of the alpha activity is from Americium-241.

The AT analyses were performed in duplicate on direct subsamples for the liquids. Solid subsamples were prepared for analysis by performing a fusion digest in duplicate. As required by the TSAP, the analysis was only requested on lower half segments. Segments 3, 4, and 6 of core 165 were subsampled into "quarter segments" and the AT analysis was requested for the lower two quarter subsegments. AT analysis was also requested for core 165, segment 3, quarter segment A (sample number S96T004889) because of the notification made for that core and segment.

Low spike recoveries were reported for core 165, segment 5, lower half (sample number S96T004924) and core 165, segment 6, quarter segment D (sample number S96T004898). These are the result of self-absorption from dissolved solids in the sample. The result for these samples may be biased low.

One preparation blank showed a result above the detection level. The level of alpha activity in the preparation blank is inconsequential when compared to the result for the sample. This contamination does not impact sample data quality.

The field blank resulted in <4.62E-07 µCi/mL. The sample results for total alpha are given in Table B2-53.

Table B2-53. Tank 241-C-104 Analytical Results: Total Alpha. (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Liquids: direct			µCi/mL	µCi/mL	µCi/mL
S96T004363	162: 3	Liquid	<0	<0	<0
S96T004828	162: 4	Liquid	<5.140E-04	<0	<8.170E-04[QC:e]
Solids: fusion			µCi/g	µCi/g	µCi/g
S96T004853	162: 1	Lower half	2.38	2.21	2.29
S96T004854	162: 2	Lower half	3.2	3.25	3.22

Table B2-53. Tank 241-C-104 Analytical Results: Total Alpha. (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
S96T004368	162: 3	Lower half	5.73	5.51	5.62
S96T004855	162: 4	Lower half	0.97	1.19	1.08
S96T004380	165: 1	Lower half	7.13	7.7	7.41
S96T004381	165: 2	Lower half	14.4	13.8	14.1
S96T004889	165: 3	Subsegment A Upper half	3.42	3.29	3.35
S96T004893		Subsegment B	36.8	39.9	38.3
S96T004894		Subsegment C	3.18	3.2	3.19
S96T004895	165: 4	Subsegment B	1.61	1.65	1.63
S96T004896		Subsegment C	4.41	4.88	4.64
S96T004924	165: 5	Lower half	2.95	2.52	2.73[QC:c]
S96T004897	165: 6	Subsegment C	0.56	0.66	0.61
S96T004898		Subsegment D Lower half	1.03	0.92	0.97[QC:c]

B2.5.2 Strontium 90

Analysis for strontium 90 was only required for the composite samples per the historical DQO. The sample results for strontium 90 are given in Table B2-54.

Table B2-54. Tank 241-C-104 Analytical Results: Strontium-89/90.

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			μCi/g	μCi/g	μCi/g
S96T004949	Core 162	Solid composite	335	327	331
S96T004956	Core 165	Solid composite	314	315	314

B2.5.3 Total Beta

Analysis for total beta was required for the composite samples per the historical DQO. The sample results for total beta are given in Table B2-55.

Table B2-55. Tank 241-C-104 Analytical Results: Total Beta.

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			μCi/g	μCi/g	μCi/g
S96T004949	Core 162	Solid composite	580	569	574
S96T004956	Core 165	Solid composite	721	696	708

B2.5.4 Total Uranium

Analysis for total uranium was only required for the composite samples per the historical DQO. Because the total alpha of core 165, segment 3, quarter segment B (sample number S96T004893) exceeded the notification limit of 31.2 μCi/g (based on a bulk density of 1.97 g/mL), an analysis for total Uranium was made to help determine the source of the alpha reading. Uranium is not a major contributor to the total alpha results. The sample results for total uranium are given in Table B2-56.

Table B2-56. Tank 241-C-104 Analytical Results: Total Uranium.

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			μg/g	μg/g	μg/g
S96T004893	165: 3	Subsegment B	29,500	30,000	29,750
S96T004949	Core 162	Solid composite	19,800	20,600	20,200
S96T004956	Core 165	Solid composite	18,300	18,000	18,150

B2.5.5 Plutonium 238/239/240

Because the total alpha of core 165, segment 3, quarter segment B (sample number S96T004893) exceeded the notification limit of 31.2 μCi/g (based on a bulk density of 1.97 g/mL), an analysis for plutonium 238/239/240 was made to help determine the source of the alpha reading. Plutonium is not a major contributor to the total alpha results and there is no criticality concern for tank 241-C-104. The sample results for plutonium are given in tables B2-57 through B2-58.

Table B2-57. Tank 241-C-104 Analytical Results: Plutonium-238.

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids			μCi/g	μCi/g	μCi/g
S96T004893	165: 3	Subsegment B	0.55	0.55	0.55

Table B2-58. Tank 241-C-104 Analytical Results: Plutonium-239/40.

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids			μCi/g	μCi/g	μCi/g
S96T004893	165: 3	Subsegment B	4.04	3.87	3.95

B2.5.6 Americium-241

Because the total alpha of core 165, segment 3, quarter segment B (sample number S96T004893) exceeded the notification limit of 31.2 μCi/g (based on a bulk density of 1.97 g/mL), an analysis for americium-241 was made to help determine the source of the alpha reading. Americium-241 is the major contributor to the total alpha results. The sample results for americium-241 are given in Table B2-59.

Table B2-59. Tank 241-C-104 Analytical Results: Americium-241 (AEA).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			μCi/g	μCi/g	μCi/g
S96T004893	165: 3	Subsegment B	43.7	42.5	43.1

Note:

AEA = alpha energy analysis

B2.5.7 Curium-243/244

Because the total alpha of core 165, segment 3, quarter segment B (sample number S96T004893) exceeded the notification limit of 31.2 μCi/g (based on a bulk density of 1.97 g/mL), an analysis for curium-243/244 was made to help determine the source of the alpha reading. Curium-243/244 was not detected. The sample results for curium-243/244 are given in Tables B2-60.

Table B2-60. Tank 241-C-104 Analytical Results: Cm-243/244 (AEA).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			μCi/g	μCi/g	μCi/g
S96T004893	165: 3	Subsegment B	<4.49	<3.96	<4.22

B2.6 GAMMA ENERGY ANALYSIS

Although the activities of selected gamma-emitting radio nuclides on solid core samples were determined by gamma energy analysis (GEA), only the analyte Cs-137 was required by the SAP. Additional GEA data were collected on an opportunistic basis and are reported here. Because data other than Cs-137 were not identified in any QC document, there were no QC requirements with respect to these data and the QC information associated with them were not evaluated for this report. All GEA results are presented in Tables B2-61 through B2-68.

Table B2-61. Tank 241-C-104 Analytical Results: Americium-241 (GEA). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			μCi/g	μCi/g	μCi/g
S96T004850	162: 1	Upper half	10.7	11	10.8
S96T004853		Lower half	<0.72	<2.39	<1.55[QC:e]
S96T004851	162: 2	Upper half	<2.22	<2.41	<2.31
S96T004854		Lower half	<2.43	<2.29	<2.36
S96T004360	162: 3	Upper half	0.02	0.03	0.03[QC:e]
S96T004368		Lower half	<0	0	<0

Table B2-61. Tank 241-C-104 Analytical Results: Americium-241 (GEA). (2 sheets)

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
S96T004852	162: 4	Upper half	<0.44	<0.37	<0.40
S96T004855		Lower half	0.29	<0.25	<0.27
S96T004380	165: 1	Lower half	<15.5	<16.2	<15.8
S96T004373	165: 2	Upper half	0.05	0.03	0.04[QC:e]
S96T004381		Lower half	8.65	<5.95	<7.30[QC:e]
S96T004889	165: 3	Subsegment A Upper half	3.67	4	3.83
S96T004893		Subsegment B	41.6	41.2	41.4
S96T004894		Subsegment C	<1.23	<1.93	<1.58[QC:e]
S96T004890	165: 4	Subsegment A Upper half	0.91	0.81	0.86
S96T004895		Subsegment B	<0.69	<0.51	<0.60
S96T004896		Subsegment C	<1.77	<1.96	<1.86
S96T004923	165: 5	Upper half	<5.16	<4.53	<4.84
S96T004924		Lower half	<5.16	<5.2	<5.18
S96T004891	165: 6	Subsegment A Upper half	<1.91	<1.94	<1.92
S96T004892		Subsegment B	<2.83	<2.74	<2.78
S96T004897		Subsegment C	<1.08	<1.04	<1.06
S96T004898		Subsegment D Lower half	<1.59	<1.57	<1.58
S96T004949	Core 162	Solid composite	3.08	<3.5	<3.29
S96T004956	Core 165	Solid composite	3.95	4.63	4.29

Table B2-62. Tank 241-C-104 Analytical Results: Cesium-137 (GEA).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			μCi/g	μCi/g	μCi/g
S96T004850	162: 1	Upper half	83.6	62.1	72.8[QC:e]
S96T004853		Lower half	<230	69.8	<150[QC:e]
S96T004851	162: 2	Upper half	55.5	56.6	56.0
S96T004854		Lower half	35.0	36	35.5
S96T004360	162: 3	Upper half	0.70	0.71	0.71
S96T004368		Lower half	0.06	0.06	0.06
S96T004852	162: 4	Upper half	50.5	36.2	43.3[QC:e]
S96T004855		Lower half	49.1	49.6	49.3
S96T004380	165: 1	Lower half	188	192	190
S96T004373	165: 2	Upper half	3.64	3.24	3.44
S96T004381		Lower half	55.7	57.4	56.5
S96T004889	165: 3	Subsegment A Upper half	66.6	62.1	64.3
S96T004893		Subsegment B	63.8	63.2	63.5
S96T004894		Subsegment C	45.9	47.8	46.8
S96T004890	165: 4	Subsegment A Upper half	45.8	42.9	44.3
S96T004895		Subsegment B	46.4	47.9	47.1
S96T004896		Subsegment C	143	140	141
S96T004923	165: 5	Upper half	67.5	59.6	63.5
S96T004924		Lower half	59.6	55	57.3
S96T004891	165: 6	Subsegment A Upper half	44.7	48.2	46.4
S96T004892		Subsegment B	40.6	47.7	44.1
S96T004897		Subsegment C	67.6	58.9	63.2
S96T004898		Subsegment D Lower half	158	151	154
S96T004949	Core 162	Solid composite	48.5	50.6	49.5
S96T004956	Core 165	Solid composite	77.0	77.7	77.3

Table B2-63. Tank 241-C-104 Analytical Results: Cobalt-60 (GEA).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			μCi/g	μCi/g	μCi/g
S96T004850	162: 1	Upper half	<0.27	0.36	<0.32
S96T004853		Lower half	<0.14	0.35	<0.24[QC:e]
S96T004851	162: 2	Upper half	0.54	0.5	0.52
S96T004854		Lower half	<0.40	<0.42	<0.41
S96T004360	162: 3	Upper half	0	0	0
S96T004368		Lower half	<4.114E-04	<3.040E-04	<3.577E-04[QC:e]
S96T004852	162: 4	Upper half	0.03	<0.02	<0.02[QC:e]
S96T004855		Lower half	0.03	0.02	0.03
S96T004380	165: 1	Lower half	<1.21	<1.69	<1.45[QC:e]
S96T004373	165: 2	Upper half	0	0	0
S96T004381		Lower half	<0.65	<0.49	<0.57
S96T004889	165: 3	Subsegment A Upper half	<0.10	<0.09	<0.09
S96T004893		Subsegment B	<0.33	0.45	<0.39
S96T004894		Subsegment C	0.11	0.16	0.14[QC:e]
S96T004890	165: 4	Subsegment A Upper half	<0.13	<0.15	<0.14
S96T004895		Subsegment B	<0.32	<0.26	<0.29
S96T004896		Subsegment C	<1.24	<1.26	<1.25
S96T004923	165: 5	Upper half	<0.63	<0.57	<0.60
S96T004924		Lower half	<0.64	<0.65	<0.64
S96T004891	165: 6	Subsegment A Upper half	<0.19	<0.25	<0.22
S96T004892		Subsegment B	<0.24	<0.24	<0.24
S96T004897		Subsegment C	<0.10	<0.09	<0.09
S96T004898		Subsegment D Lower half	<0.08	<0.08	<0.08
S96T004949	Core 162	Solid composite	<0.33	<0.44	<0.39
S96T004956	Core 165	Solid composite	0.16	0.18	0.17

Table B2-64. Tank 241-C-104 Analytical Results: Europium-154 (GEA).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			μCi/g	μCi/g	μCi/g
S96T004850	162: 1	Upper half	3.03	3.07	3.05
S96T004853		Lower half	<0.24	<0.75	<0.50[QC:e]
S96T004851	162: 2	Upper half	<0.58	<0.61	<0.59
S96T004854		Lower half	<1.39	<1.31	<1.35
S96T004360	162: 3	Upper half	0.01	0.01	0.01
S96T004368		Lower half	<9.911E-04	<0	<0
S96T004852	162: 4	Upper half	<0	<0	<0.05
S96T004855		Lower half	<0.02	<0.02	<0.02
S96T004380	165: 1	Lower half	<6.30	<7.08	<6.69
S96T004373	165: 2	Upper half	0.06	0.05	0.06
S96T004381		Lower half	<1.88	<2.06	<1.97
S96T004889	165: 3	Subsegment A Upper half	<0.18	<0.22	<0.20
S96T004893		Subsegment B	<0.76	<0.75	<0.76
S96T004894		Subsegment C	<0.21	<0.22	<0.21
S96T004890	165: 4	Subsegment A Upper half	<0.41	<0.39	<0.40
S96T004895		Subsegment B	<0.85	<0.84	<0.85
S96T004896		Subsegment C	<3.02	<3.47	<3.24
S96T004923	165: 5	Upper half	<1.42	<1.6	<1.51
S96T004924		Lower half	<1.69	<1.92	<1.80
S96T004891	165: 6	Subsegment A Upper half	<0.55	<0.58	<0.56
S96T004892		Subsegment B	<0.83	<0.77	<0.80
S96T004897		Subsegment C	<0.17	<0.23	<0.20
S96T004898		Subsegment D Lower half	<0.16	<0.12	<0.14
S96T004949	Core 162	Solid composite	<1.07	<1.32	<1.19
S96T004956	Core 165	Solid composite	0.63	0.67	0.654

Table B2-65. Tank 241-C-104 Analytical Results: Europium-155 (GEA).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			µCi/g	µCi/g	µCi/g
S96T004850	162: 1	Upper half	<1.49	<1.39	<1.44
S96T004853		Lower half	<0.30	<0.88	<0.59[QC:e]
S96T004851	162: 2	Upper half	<0.89	<0.91	<0.90
S96T004854		Lower half	<1.19	<1.11	<1.15
S96T004360	162: 3	Upper half	<0	<0	<0
S96T004368		Lower half	<0	<0	<0
S96T004852	162: 4	Upper half	<0.21	<0.17	<0.19
S96T004855		Lower half	<0.07	<0.08	<0.07
S96T004380	165: 1	Lower half	<6.35	<6.39	<6.37
S96T004373	165: 2	Upper half	0.04	0.04	0.04
S96T004381		Lower half	<2.20	<2.09	<2.14
S96T004889	165: 3	Subsegment A Upper half	<0.42	<0.40	<0.41
S96T004893		Subsegment B	<0.91	<0.96	<0.94
S96T004894		Subsegment C	<0.39	<0.40	<0.4
S96T004890	165: 4	Subsegment A Upper half	<0.40	<0.39	<0.40
S96T004895		Subsegment B	<0.88	<0.84	<0.86
S96T004896		Subsegment C	<3.17	<3.41	<3.29
S96T004923	165: 5	Upper half	<2.06	<1.79	<1.92
S96T004924		Lower half	<2.07	<1.97	<2.02
S96T004891	165: 6	Subsegment A Upper half	<0.87	<0.84	<0.85
S96T004892		Subsegment B	<1.00	<1.05	<1.02
S96T004897		Subsegment C	<0.52	<0.50	<0.51
S96T004898		Subsegment D Lower half	<0.60	<0.59	<0.60
S96T004949	Core 162	Solid composite	<1.37	<1.36	<1.36
S96T004956	Core 165	Solid composite	<0.35	<0.31	<0.33

Table B2-66. Tank 241-C-104 Analytical Results: Neptunium-237 (GEA).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			µCi/g	µCi/g	µCi/g
S96T004893	165: 3	Subsegment B	<2.13	<2.13	<2.13

Table B2-67. Tank 241-C-104 Analytical Results: Uranium-233 (GEA).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			µCi/g	µCi/g	µCi/g
S96T004893	165: 3	Subsegment B	<207	<210	<208

Table B2-68. Tank 241-C-104 Analytical Results: Uranium-235 (GEA).

Sample Number	Sample Location	Sample Portion	Result	Duplicate	Mean
Solids: fusion			µCi/g	µCi/g	µCi/g
S96T004893	165: 3	Subsegment B	<0.35	<0.34	<0.34

B2.7 VAPOR PHASE MEASUREMENT

B2.7.1 Safety Screening and Flammable Gas Monitoring

Before the July push mode core sampling of tank 241-C-104, vapor phase measurements were taken. These measurements supported the safety screening DQO (Dukelow et al. 1995). The vapor phase screening was taken for flammability issues. The vapor phase measurements were taken 6 m (20 ft) below the risers in the headspace of the tank and results were obtained in the field (i.e., no gas sample was sent to the laboratory for analysis). The results of the vapor phase measurements are provided in Table B2-50.

Table B2-69. Results of Vapor Phase Measurements of Tank 241-C-104.

Measurement	Result	
	July 29, 1996	July 30, 1996
Total organic carbon (TOC)	11 ppm	1.7 ppm
Lower explosive limit (LEL)	0% of LEL	0% of LEL
Oxygen	21%	20.7%
Ammonia	40 ppm	<5 ppm

B2.7.2 1995 Tank Vapor Samples

Headspace gas and vapor samples were collected from tank 241-C-104 using the vapor sampling system (VSS) on February 17, 1994 and March 3, 1994 by WHC Sampling and Mobile Laboratories.

B2.7.3 Summary of Vapor Sampling Results

Quantitative results were obtained for the inorganic compounds ammonia (NH_3), nitrogen oxide (NO_2), nitrous oxide (NO), sulfur oxide (SO_x), and water (H_20). Organic compounds were also quantitatively determined. Occupational Safety and Health Administration (OSHA) versatile sampler (OVS) tubes were analyzed for tributyl phosphate. Twenty-four organic tentatively identified compounds (TICs) were observed above the detection limit of (ca.) 10 ppbv, but standards for most of these were not available at the time of analysis, and the reported concentrations are semiquantitative estimates. The 10 organic analytes with the highest estimated concentrations are listed in Table B2-70. These 10 analytes account for approximately 88 percent of the total organic components in the headspace of tank 241-C-104.

Complete vapor sampling analytical results are reported in Lucke et al. (1995).

Table B2-70. Summary Results of Inorganic and Organic Samples Collected from the Headspace of Tank 241-C-104 on February 7 and March 3, 1994.

Category	Analyte	Vapor[1] Concentration	Units
Inorganic	NH^3	44 ± 0	ppmv
	NO_2	≤0.02	ppmv
	NO	0.37 ± 0.05	ppmv
	SO_x	0.4 ± 0.2	ppmv
	H_2O	15 ± 1	mg/L
Organic	Dodecane	6.47	mg/m^3
	Tridecane	6.22	mg/m^3
	Undecane	4.88	mg/m^3
	1-Butanol	2.45	mg/m^3
	Tetradecane	0.96	mg/m^3
	Decane	0.95	mg/m^3
	Butane	0.59	mg/m^3
	Butanol	0.47	mg/m^3
	Propane	0.46	mg/m^3
	3-Heptanone	0.41	mg/m^3

Note:

[1]Vapor concentrations were determined using sample-volume data provided by Westinghouse Hanford Company and are based on averaged data. The inorganic samples were obtained and analyzed using procedures that were subsequently improved. The SO_x values, in particular, may have been biased by unknown sampling or analytical errors.

B2.8 HISTORICAL SAMPLE RESULTS

A core sample was obtained from tank 241-C-104, riser 8, in April 1986. This core consisted of 6 segments which were combined to generate a composite sample for chemical and radionuclide analysis of the waste (Weiss and Schull 1988). Metals were determined by ICP, while anions were measured by IC. The results of those analyses are provided in Table B2-71 and B2-72.

Table B2-71. 1986 Sample[1]. (3 sheets)

COMPONENT	LAB VALUE	LAB UNIT
Physical Data		
Sample Description	Dark Brown to White	
Density	1.21	g/mL
Chemical Analysis		
Al	30,100	μg/g
Ba	3,900	μg/g
Bi	3,640	μg/g
B	17.1	μg/g
Cd	1,280	μg/g
Ca	11,300	μg/g
Chemical Analysis		
Cr	1,120	μg/g
Co	16.2	μg/g
Cu	112	μg/g
Fe	26,100	μg/g
Pb	818	μg/g
Mg	5,460	μg/g
Mn	3,280	μg/g
Ni	1,910	μg/g

Table B2-71. 1986 Sample[1]. (3 sheets)

COMPONENT	LAB VALUE	LAB UNIT
NO_3	23,400	μg/g
P as PO_4	9,590	μg/g
K	1,350	μg/g
Si	56,400	μg/g
Ag	468	μg/g
Na	95,500	μg/g
Sr	81.2	μg/g
TOC	4,410	μg/g
U	16,100	μg/g
Zn	117	μg/g
Zr	61,800	μg/g
Radionuclide		
^{14}C	6.22E-04	(μCi/g)[2]
^{60}Co	0.195	(μCi/g)[2]
^{90}Sr	306	(μCi/g)[2]
^{99}Tc	2.77	(μCi/g)[2]
^{129}I	0	(μCi/g)[2]
^{137}Cs	26.1	(μCi/g)[2]

Table B2-71. 1986 Sample[1]. (3 sheets)

COMPONENT	LAB VALUE	LAB UNIT
$^{239/240}Pu^{3}$	2.96	$(\mu Ci/g)^2$
^{241}Am	3.11	$(\mu Ci/g)^2$
Total gamma	48.4	$(\mu Ci/g)^2$

Notes:

[1]Pre-1989 analytical data have not been validated and should be used with caution.

[2]Based on decayed mean of 1986 core sample sludge (Weiss and Schull 1988). Decayed to January 1, 1994.

[3]Corrected value from ECN 164204 to Weiss and Schull (1988)

Table B2-72. 1988 Supernatant Sample.[1] (2 sheets)

COMPONENT	LAB VALUE	LAB UNIT
Physical Data		
Sample description	Bright Yellow	
pH	11.5	
Specific gravity	1.18	
Water	NA	%
Chemical Analysis		
U	0.025	g/L
TOC	10.3	g/L
Radionuclide		
^{14}C	1.33	μCi/L
^{60}Co	398	μCi/L
^{90}Sr	13,000	μCi/L
^{99}Tc	27.8	μCi/L
^{137}Cs	118,000	μCi/L

Table B2-72. 1988 Supernatant Sample.[1] (2 sheets)

COMPONENT	LAB VALUE	LAB UNIT
$^{239/240}Pu$[3]	2.96	μCi/L
^{241}Am	<0.8	μCi/L
Total gamma	118,000	μCi/L

Note:
[1]Pre-1989 analytical data have not been validated and should be used with caution.

Eight additional solid sample events occurred in tank 241-C-104 dating back to 1974. Details of these events are sketchy and the results do not reflect the current waste.

A vapor sample was also taken in August of 1988. The only constituent of significance that was detected was ammonia at 151 mg/m^3. The threshold limit for ammonia is 150 mg/m^3.

B3.0 ASSESSMENT OF CHARACTERIZATION RESULTS

The purpose of this chapter is to discuss the overall quality and consistency of the current sampling results for tank 241-C-104.

This section also evaluates sampling and analysis factors that may impact interpretation of the data. These factors are used to assess the overall quality and consistency of the data and to identify any limitations in the use of the data.

B3.1 FIELD OBSERVATIONS

In July, 1996, two push mode core samples were obtained from risers 3 and 14 of tank 241-C-104. Core 162 from riser 3 contained 4 segments, with the top of the first segment located approximately 63.5 cm (25 in.) below the anticipated top of the sludge surface and the bottom of segment 4 about 2.54 cm (1 in.) above the bottom of the tank because of an undocumented offset in the elevation of the riser spool. The second core, core 165 from riser 14, was a full-depth core consisting of 6 segments.

Sample recovery was good for all segments with exception of the first segment of core 165, which was only intended to be a partial segment. These cores show that the average sludge depth beneath the risers is about 253.6 cm (99.8 in.), which is higher than the measured depth of 221.7 cm (87.3 in.) as of January 1993 (Swaney 1993) but slightly lower than the 260.9 cm (102.7 in.) depth cited by Hanlon in the Waste Status Summary Report (Hanlon 1997). There is no indication of the use of hydrostatic head fluid in procuring these samples. A blank was not provided to the 222-S Laboratory.

B3.2 QUALITY CONTROL ASSESSMENT

The usual quality control assessment includes an evaluation of the appropriate standard recoveries, spike recoveries, duplicate analyses, and blanks that are performed in conjunction with the chemical analyses. With exception of analytes recorded on an opportunistic basis (Kristofzski 1995), all required analytes included the pertinent quality control tests allowing a full assessment regarding the accuracy and precision of the data. The SAP established the specific criteria for all analytes. Sample and duplicate pairs that had one or more QC results outside the specified criteria were identified by footnotes in the data summary tables.

The standard and spike recovery results provide an estimate of the accuracy of the analysis. If a standard or spike recovery is above or below the given criterion, the analytical results may be biased high or low, respectively. The precision is estimated by the relative percent difference (RPD), which is defined as the absolute value of the difference between the primary and duplicate samples, divided by their mean, times one hundred.

None of the subsamples submitted for DSC exceeded the notification limits as stated in the TSAP. The DSC analyses were performed in duplicate on direct subsamples. The exothermic energy based on dry weight of subsample was calculated for all subsamples. The average of the TGA results for each subsample was used in the dry weight correction for that subsample. Relative percent differences greater than 30 percent were reported for five of the twenty-five subsamples. The results of four of these subsamples were near the detection limit for the instrument and resulted in a decrease in precision. No further analysis for these subsamples was requested. A second analysis of core 165, segment 5, upper half (sample number S96T004919) was performed. Sample inhomogeneity appears to be the cause of the initial high RPD. Further analyses of these subsamples by DSC would not provide any more information. The chemist noted that the thermogram for core 162, segment 3, upper half (sample number S96T004358) shows an inflection at approximately 300 °C (572 °F) that may indicate a change in the heat capacity of the sample. The field blank resulted in 0.00 J/g.

The TGA analyses were performed in duplicate on direct subsamples. Results were determined by summing weight loss steps below 200 °C (392 °F); weight loss steps above this were not used to determine the result. More information may be obtained by examining the raw data. An RPD greater than 30 percent was reported for one of the twenty-five subsamples: core 162, segment 4, lower half (sample number S96T004843). A second analysis of this subsample was performed. Sample inhomogeneity appears to be the cause for the high RPD. The field blank showed 100.0 percent water content.

The TOC subsample from core 165, segment 6, quarter segment D (sample number S96T004881) had a spike recovery of 73.8 percent. If the spike recovery is calculated using the duplicate result, it is within the specified QC range of 75 to 125 percent suggesting sample heterogeneity. Rerun analyses would not significantly improve the results.

Two TIC subsamples had RPDs slightly outside the QC parameter ±15 percent. Four subsamples had spike recoveries slightly outside the QC range 80 to 120 percent. Reruns were not requested.

For ICP sample number S96T004893, the reported spike recovery for Na is for a 1 ppm spike. A spike of this level is invalid. A second spike was run at 10 ppm resulting in a spike recovery of 88.3 percent. This spike and calculation can be found in the raw data. Reported Ni results are from a fusion preparation in an Ni crucible. These results may be biased high. Li was detected at 3.5 μg/g for the core 162 composite (sample number S96T004950). There is no indication of hydrostatic head fluid use for procuring these samples. The laboratory can offer no explanation for this presence. Preparation blanks showed Al, Fe, Ni, and Na results above the detection level. The levels of these analytes in the preparation blank are inconsequential when compared to the result for the sample. This slight degree of contamination does not impact sample data quality.

One of the seventeen subsamples submitted for total alpha activity analysis (AT) exceeded the notification limit of 31.2 μCi/g. Additional analyses in accordance with the TSAP and direction from the tank coordinator indicate ^{241}Am accounts for the majority of alpha activity for that subsegment with approximately 10 percent being attributable to $^{239/240}$Pu.

The AT analyses were performed in duplicate on direct subsamples for the liquids. Solid subsamples were prepared for analysis by performing a fusion digest in duplicate. As required by the TSAP, the analysis was only requested on lower half segments. Segments 3, 4, and 6 of core 165 was subsampled into "quarter segments" and the AT analysis was requested for the lower two quarter subsegments.

AT analysis was also requested for core 165, segment 3, quarter segment A (sample number S96T004889) due to the notification made for that core and segment. Low spike recoveries were reported for core 165, segment 5, lower half (sample number S96T004924) and core 165, segment 6, quarter segment D (sample number S96T004898). These are the results of self-absorption from dissolved solids in the sample. The result for these samples may be biased low. One preparation blank showed a result above the detection level. The level of alpha activity in the preparation blank is inconsequential when compared to the result for the sample. This slight degree of contamination does not impact sample data quality. The field blank resulted in <4.62E-7 μCi/mL.

For GEA analyte results, rerun analysis of sample numbers S96T004850, S96T004852, and S96T004853 show the high RPDs to be the result of heterogeneity problems between the sample and duplicate preparation. The levels of ^{137}Cs and the relatively low RPDs do not warrant the preparation of another fusion for these samples. Two preparation blanks showed

^{137}Cs activity above the detection level. The activity in the preparation blank is inconsequential when compared to the result for the sample. This slight degree of contamination does not impact sample data quality.

The preparation blanks showed ^{90}Sr activity above the detection level. The activity in these preparation blanks is inconsequential when compared to the results for the samples. This contamination does not impact sample data quality.

In summary, the vast majority of the QC results were within the boundaries specified in the SAP. The discrepancies mentioned here and footnoted in the data summary tables should not impact either the validity or the use of the data.

B3.3 DATA CONSISTENCY CHECKS

Comparisons of different analytical methods can help to assess the consistency and quality of the data. Several comparisons were possible with the data set provided by the two core samples. Including a comparison of phosphorous as analyzed by ICP with phosphate as analyzed by IC. In addition, mass and charge balances were calculated to help assess the overall data consistency.

B3.3.1 Comparison of Results from Different Analytical Methods

The following data consistency checks compare the results from two different analytical methods. Close agreement between the two methods strengthens the credibility of both results, whereas poor agreement brings the reliability of the data into question. All analytical mean results were taken from Table B3-5.

Phosphate and sulfate data were measured by IC, and phosphorous and sulfur were measured by ICP. This allows a comparison of the IC and ICP results. The mean phosphorous core composite result as determined by water digested ICP was 1020 μg/g. This result was higher than the results on the acid-digested and fusion digested samples and was the one used for comparison to the water-digested IC phosphate result. The concentration of phosphorous found converts to 3,127 μg/g of phosphate. This compares with the water digested IC mean core composite phosphate result of 2,460 μg/g. The RPD between these two phosphate results was 24 percent.

The mean sulfur core composite result on the water-digested sample was 786 μg/g. This result was higher then the results on the acid-digested and fusion digested samples and was the one used for comparison to the water-digested IC sulphate result. The concentration of sulfur found converts to 2,355 μg/g of sulphate. This compares with the water digested IC mean core composite sulphate result of 2,710 μg/g. The RPD between these two phosphate results was 14 percent.

B3.3.2 Mass and Charge Balance

The principal objective in performing mass and charge balances is to determine if the measurements are consistent. In calculating the balances, only analytes listed in Table B3-5 detected at a concentration of 1,000 μg/g or greater were considered.

Except sodium, all cations listed in Table B3-1 were assumed to be in their most common hydroxide or oxide form, and the concentrations of the assumed species were calculated stoichiometrically. Because precipitates are neutral species, all positive charge was attributed to the sodium cation. The anions listed in Table B3-2 were assumed to be present as sodium salts and were expected to balance the positive charge exhibited by the cations. Phosphate, and sulfate as determined by IC, are assumed to be completely water soluble and appears only in the anion mass and charge calculations. The concentrations of cationic species in Table B3-1, the anionic species in Table B3-2, and the percent water were ultimately used to calculate the mass balance.

The mass balance was calculated from the formula below. The factor 0.0001 is the conversion factor from μg/g to weight percent.

$$\text{Mass balance} = \%\ \text{Water} + 0.0001 \times \{\text{Total Analyte Concentration}\}$$

$$= \%\ \text{Water} + 0.0001 \times \{Al(OH)_3 + Cr(OH)_3 + FeO(OH) + MnO^2 + Na^+ + U_3O_8 + ZrO(OH)_2$$
$$F^- + NO_3^- + NO_2^- + (COO)_2^{-2} + PO_4^{-3} + SiO_3^{-2} + SO_4^{-2} + CO_3^{-2} + C_2H_3O_3^-\}$$

The total analyte concentration calculated from the above equation is 502,821 μg/g. The mean weight percent water (obtained from the gravimetric analyses reported in Table B3-5) is 50.8 percent, or 508,000 μg/g. The mass balance resulting from adding the percent water to the total analyte concentration is 97.5 percent (Table B3-3).

The following equations demonstrate the derivation of total cations and total anions; the charge balance is the ratio of these two values.

<u>Total cations</u> (μeq/g) = $[Na^+]/23.0 = 4{,}820\ \mu eq/g$

<u>Total anions</u> (μeq/g) = $[F^-]/19 + [NO_3^-]/62 + [NO_2^-]/46 + 2[(COO)_2^{-2}]/56 + 3[PO_4^{-3}]/95 + 2[SiO_3^{-2}]/76 + 2[SO_4^{-2}]/96 + 2[CO_3^{-2}]/60 + [C_2H_3O_3^-]/75 = 4{,}674\ \mu eq/g$

The charge balance obtained by dividing the sum of the positive charge by the sum of the negative charge was 1.03.

In summary, the above calculations yield reasonable mass and charge balance values (close to 1.00 for charge balance and 100 percent for mass balance), indicating that the analytical results are generally self-consistent.

Table B3-1. Cation Mass and Charge Data.

Analyte	Concentration ($\mu g/g$)	Assumed Species	Concentration of Assumed Species ($\mu g/g$)	Charge ($\mu eq/g$)
Aluminum	46,000	$Al(OH)_3$	132888	
Chromium	1,010	$Cr(OH)_3$	2020	
Iron	23,700	FeO(OH)	37601	
Manganese	4,560	MnO_2	7214	
Sodium	111,000	Na^+	111000	4,820
Uranium	212,000	U_3O_8	25,000	
Zirconium	34,700	$ZrO(OH)_2$	53766	
Total			369489	4,820

Table B3-2. Anion Mass and Charge Data.

Analyte	Concentration ($\mu g/g$)	Assumed Species	Concentration of Assumed Species ($\mu g/g$)	Charge ($\mu eq/g$)
Fluoride	15,400	F^-	15,400	811
Nitrate	11,500	NO_3^-	11,500	185
Nitrite	21,600	NO_2^-	21,600	470
Oxalate	7,080	$(COO)_2^{-2}$	7,080	161
Phosphate	2,260	PO_4^{-3}	2,260	71
Silicon	6,060	SiO_3^{-2}	6,060	159
Sulphate	2,820	SO_4^{-2}	2,820	59
TIC	7,010	CO_3^{-2}	35,050	2,337
TOC	10,100	$C_2H_3O_3^-$	31,562	421
Total			133,332	4674

Table B3-3. Mass Balance Totals..

Totals	Concentrations ($\mu g/g$)
Total from Table B3-1	369,489
Total from Table B3-2	133,332
Percent water	508,000
Grand total	1,010,821

B3.4 MEAN CONCENTRATIONS AND CONFIDENCE INTERVALS

The following evaluation was performed on the analytical data from the samples from tank 241-C-104.

Because an inventory estimate is needed without comparing it to a threshold value, two-sided 95 percent confidence intervals on the mean are computed. This was done with both the composite-level and segment-level data. With segment-level data, inventories were computed for only solid segment sample data.

The upper and lower limits (UL and LL) to a two-sided 95% confidence interval for the mean are

$$\hat{\mu} \pm t_{(df,0.025)} \times \hat{\sigma}_{\hat{\mu}}.$$

In this equation, $\hat{\mu}$ is the estimate of the mean concentration, $\hat{\sigma}_{\hat{\mu}}$ is the estimate of the standard deviation of the mean concentration, and $t_{(df,0.025)}$ is the quantile from Student's t distribution with df degrees of freedom for a two-sided 95 percent confidence interval.

The mean, $\hat{\mu}$, and the standard deviation, $\hat{\sigma}_{\hat{\mu}}$, were estimated using restricted maximum likelihood estimation (REML) methods. The degrees of freedom (df), for tank 241-C-104, is the number of cores sampled minus one.

B3.4.1 Composite, Solid Segment, and Liquid Segment Means

The statistics in this section were based on analytical data from the most recent sampling event of tank 241-C-104. Analysis of variance (ANOVA) techniques were used to estimate the mean, and calculate confidence limits on the mean, for all analytes that had at least 50 percent of reported values above the detection limit. If at least 50 percent of the reported values were above the detection limit, all of the data was used in the computations. The detection limit was used as the value for nondetected results. No ANOVA estimates were computed for analytes with less than 50 percent detected values. Only arithmetic means were computed for these analytes.

The results given below are ANOVA estimates based on the core composite data from core 162 and core 165 for tank 241-C-104. Estimates of the mean concentration, and confidence interval on the mean concentration, are given in Table B3-4. The lower limit, (LL), to a 95 percent confidence interval can be negative. Because an actual concentration of less than zero is not possible, the lower limit is reported as zero, whenever this occurred.

Table B3-4. 95 Percent Two-Sided Confidence Interval for the Mean Concentration for Composite Sample Data. (5 sheets)

Analyte	Units	$\hat{\mu}$	$\hat{\sigma}_{\hat{\mu}}$	df	LL	UL
ICP.a.Al	μg/g	4.99E+04	1.88E+04	1	0.00E+00	2.89E+05
ICP.f.Al	μg/g	5.44E+04	2.33E+04	1	0.00E+00	3.50E+05
ICP.w.Al	μg/g	6.77E+02	8.25E+00	1	5.72E+02	7.82E+02
ICP.a.Sb[1]	μg/g	<1.77E+01	n/a	n/a	n/a	n/a
ICP.f.Sb[1]	μg/g	<1.31E+03	n/a	n/a	n/a	n/a
ICP.w.Sb[1]	μg/g	<1.25E+02	n/a	n/a	n/a	n/a
Am-241[2]	μCi/g	3.79E+00	4.99E-01	1	0.00E+00	1.01E+01
ICP.a.As[1]	μg/g	<2.94E+01	n/a	n/a	n/a	n/a
ICP.f.As[1]z	μg/g	<2.19E+03	n/a	n/a	n/a	n/a
ICP.w.As[1]	μg/g	<2.08E+02	n/a	n/a	n/a	n/a
ICP.a.Ba	μg/g	8.89E+01	1.08E+01	1	0.00E+00	2.26E+02
ICP.f.Ba[1]	μg/g	<1.09E+03	n/a	n/a	n/a	n/a
ICP.w.Ba[1]	μg/g	<1.04E+02	n/a	n/a	n/a	n/a
ICP.a.Be	μg/g	2.30E+01	7.63E+00	1	0.00E+00	1.20E+02
ICP.f.Be[1]	μg/g	<1.09E+02	n/a	n/a	n/a	n/a
ICP.w.Be[1]	μg/g	<1.04E+01	n/a	n/a	n/a	n/a
ICP.a.Bi[1]	μg/g	<2.94E+01	n/a	n/a	n/a	n/a
ICP.f.Bi[1]	μg/g	<2.19E+03	n/a	n/a	n/a	n/a
ICP.w.Bi[1]	μg/g	<2.08E+02	n/a	n/a	n/a	n/a
ICP.a.B	μg/g	1.14E+02	1.36E+01	1	0.00E+00	2.86E+02
ICP.f.B[1]	μg/g	<1.09E+03	n/a	n/a	n/a	n/a
ICP.w.B	μg/g	1.08E+03	2.64E+02	1	0.00E+00	4.44E+03

Table B3-4. 95 Percent Two-Sided Confidence Interval for the Mean Concentration for Composite Sample Data. (5 sheets)

Analyte	Units	$\hat{\mu}$	$\hat{\sigma}_{\hat{\mu}}$	df	LL	UL
Bromide[1]	μg/g	<7.74E+02	n/a	n/a	n/a	n/a
ICP.a.Cd	μg/g	5.91E+02	2.63E+02	1	0.00E+00	3.93E+03
ICP.f.Cd	μg/g	6.20E+02	2.59E+02	1	0.00E+00	3.91E+03
ICP.w.Cd	μg/g	2.02E+01	7.97E+00	1	0.00E+00	1.22E+02
ICP.a.Ca	μg/g	1.80E+03	3.03E+02	1	0.00E+00	5.65E+03
ICP.f.Ca[1]	μg/g	<2.19E+03	n/a	n/a	n/a	n/a
ICP.w.Ca[1]	μg/g	<2.08E+02	n/a	n/a	n/a	n/a
ICP.a.Ce	μg/g	4.28E+01	9.03E+00	1	0.00E+00	1.57E+02
ICP.f.Ce[1]	μg/g	<2.19E+03	n/a	n/a	n/a	n/a
ICP.w.Ce[1]	μg/g	<2.08E+02	n/a	n/a	n/a	n/a
Cs-137	μCi/g	6.35E+01	1.39E+01	1	0.00E+00	2.40E+02
Chloride	μg/g	4.83E+02	2.66E+02	1	0.00E+00	3.86E+03
ICP.a.Cr	μg/g	8.15E+02	1.11E+02	1	0.00E+00	2.22E+03
ICP.f.Cr	μg/g	8.82E+02	4.78E+01	1	2.75E+02	1.49E+03
ICP.w.Cr	μg/g	7.49E+01	1.85E+01	1	0.00E+00	3.10E+02
ICP.a.Co[1]	μg/g	<5.89E+00	n/a	n/a	n/a	n/a
ICP.f.Co[1]	μg/g	<4.37E+02	n/a	n/a	n/a	n/a
ICP.w.Co[1]	μg/g	<4.15E+01	n/a	n/a	n/a	n/a
Co-60[2]	μCi/g	2.84E-01	1.07E-01	1	0.00E+00	1.64E+00
ICP.a.Cu	μg/g	8.08E+01	3.37E+01	1	0.00E+00	5.09E+02
ICP.f.Cu[1]	μg/g	<2.19E+02	n/a	n/a	n/a	n/a
ICP.w.Cu[1]	μg/g	<2.08E+01	n/a	n/a	n/a	n/a
Eu-154[2]	μCi/g	9.25E-01	2.71E-01	1	0.00E+00	4.37E+00
Eu-155[1]	μCi/g	<8.53E-01	n/a	n/a	n/a	n/a
DSC	J/g	0.00E+00	0.00E+00	1	0.00E+00	0.00E+00
Fluoride	μg/g	2.09E+04	6.69E+03	1	0.00E+00	1.06E+05
Gross Beta	μCi/g	6.42E+02	6.70E+01	1	0.00E+00	1.49E+03
ICP.a.Fe	μg/g	1.61E+04	1.88E+03	1	0.00E+00	3.99E+04
ICP.f.Fe	μg/g	1.67E+04	1.65E+03	1	0.00E+00	3.76E+04
ICP.w.Fe[1]	μg/g	<1.04E+02	n/a	n/a	n/a	n/a

Table B3-4. 95 Percent Two-Sided Confidence Interval for the Mean Concentration for Composite Sample Data. (5 sheets)

Analyte	Units	$\hat{\mu}$	$\hat{\sigma}_{\hat{\mu}}$	df	LL	UL
ICP.a.La	µg/g	2.94E+01	2.03E+00	1	3.64E+00	5.51E+01
ICP.f.La[1]	µg/g	<1.09E+03	n/a	n/a	n/a	n/a
ICP.w.La[1]	µg/g	<1.04E+02	n/a	n/a	n/a	n/a
ICP.a.Pb	µg/g	5.05E+02	1.08E+01	1	3.69E+02	6.42E+02
ICP.f.Pb[1]	µg/g	<2.19E+03	n/a	n/a	n/a	n/a
ICP.w.Pb[1]	µg/g	<2.08E+02	n/a	n/a	n/a	n/a
ICP.a.Li[2]	µg/g	3.65E+00	2.50E-01	1	4.73E-01	6.83E+00
ICP.f.Li[1]	µg/g	<2.19E+02	n/a	n/a	n/a	n/a
ICP.w.Li[1]	µg/g	<2.08E+01	n/a	n/a	n/a	n/a
ICP.a.Mg[2]	µg/g	1.24E+02	1.05E+02	1	0.00E+00	1.45E+03
ICP.f.Mg[1]	µg/g	<2.19E+03	n/a	n/a	n/a	n/a
ICP.w.Mg[1]	µg/g	<2.08E+02	n/a	n/a	n/a	n/a
ICP.a.Mn	µg/g	4.07E+03	7.95E+02	1	0.00E+00	1.42E+04
ICP.f.Mn	µg/g	4.24E+03	8.85E+02	1	0.00E+00	1.55E+04
ICP.w.Mn[1]	µg/g	<2.08E+01	n/a	n/a	n/a	n/a
ICP.a.Mo[1]	µg/g	<1.47E+01	n/a	n/a	n/a	n/a
ICP.f.Mo[1]	µg/g	<1.09E+03	n/a	n/a	n/a	n/a
ICP.w.Mo[1]	µg/g	<1.04E+02	n/a	n/a	n/a	n/a
ICP.a.Nd	µg/g	6.45E+01	7.93E+00	1	0.00E+00	1.65E+02
ICP.f.Nd[1]	µg/g	<2.19E+03	n/a	n/a	n/a	n/a
ICP.w.Nd[1]	µg/g	<2.08E+02	n/a	n/a	n/a	n/a
ICP.a.Ni	µg/g	1.59E+03	1.55E+02	1	0.00E+00	3.56E+03
ICP.f.Ni	µg/g	1.26E+04	3.68E+03	1	0.00E+00	5.93E+04
ICP.w.Ni	µg/g	8.88E+01	4.07E+01	1	0.00E+00	6.06E+02
Nitrate	µg/g	1.18E+04	3.55E+03	1	0.00E+00	5.69E+04
Nitrite	µg/g	2.20E+04	5.91E+03	1	0.00E+00	9.71E+04
Oxalate	µg/g	3.39E+03	6.99E+02	1	0.00E+00	1.23E+04
% Water	%	4.79E+01	4.98E+00	1	0.00E+00	1.00E+02
Phosphate	µg/g	2.46E+03	1.46E+02	1	6.11E+02	4.31E+03
ICP.a.P	µg/g	6.32E+02	5.13E+02	1	0.00E+00	7.15E+03

Table B3-4. 95 Percent Two-Sided Confidence Interval for the Mean Concentration for Composite Sample Data. (5 sheets)

Analyte	Units	$\hat{\mu}$	$\hat{\sigma}_{\hat{\mu}}$	df	LL	UL
ICP.f.P[1]	μg/g	<4.37E+03	n/a	n/a	n/a	n/a
ICP.w.P	μg/g	1.02E+03	7.75E+01	1	3.78E+01	2.01E+03
ICP.a.K	μg/g	8.04E+02	1.78E+02	1	0.00E+00	3.06E+03
ICP.w.K[1]	μg/g	<1.04E+03	n/a	n/a	n/a	n/a
ICP.a.Sm[1]	μg/g	<2.94E+01	n/a	n/a	n/a	n/a
ICP.f.Sm[1]	μg/g	<2.19E+03	n/a	n/a	n/a	n/a
ICP.w.Sm[1]	μg/g	<2.08E+02	n/a	n/a	n/a	n/a
ICP.a.Se[1]	μg/g	<2.94E+01	n/a	n/a	n/a	n/a
ICP.f.Se[1]	μg/g	<2.19E+03	n/a	n/a	n/a	n/a
ICP.w.Se[1]	μg/g	<2.08E+02	n/a	n/a	n/a	n/a
ICP.a.Si	μg/g	4.20E+03	7.48E+02	1	0.00E+00	1.37E+04
ICP.f.Si	μg/g	4.97E+03	9.35E+02	1	0.00E+00	1.68E+04
ICP.w.Si	μg/g	6.18E+03	2.56E+03	1	0.00E+00	3.87E+04
ICP.a.Ag	μg/g	2.54E+02	5.08E+01	1	0.00E+00	8.99E+02
ICP.f.Ag	μg/g	6.37E+02	1.92E+01	1	3.94E+02	8.81E+02
ICP.w.Ag[2]	μg/g	2.13E+01	4.71E-01	1	1.53E+01	2.73E+01
ICP.a.Na	μg/g	7.49E+04	3.18E+03	1	3.45E+04	1.15E+05
ICP.f.Na	μg/g	1.08E+05	1.50E+03	1	8.84E+04	1.27E+05
ICP.w.Na	μg/g	7.18E+04	2.28E+03	1	4.29E+04	1.01E+05
ICP.a.Sr	μg/g	5.28E+01	1.75E+00	1	3.05E+01	7.51E+01
ICP.f.Sr[1]	μg/g	<2.19E+02	n/a	n/a	n/a	n/a
ICP.w.Sr[1]	μg/g	<2.08E+01	n/a	n/a	n/a	n/a
Sr-89/90	μCi/g	3.23E+02	8.25E+00	1	2.18E+02	4.28E+02
Sulfate	μg/g	2.71E+03	6.75E+02	1	0.00E+00	1.13E+04
ICP.a.S	μg/g	6.88E+02	1.22E+02	1	0.00E+00	2.24E+03
ICP.f.S[1]	μg/g	<2.19E+03	n/a	n/a	n/a	n/a
ICP.w.S	μg/g	7.86E+02	1.87E+02	1	0.00E+00	3.16E+03
ICP.a.Tl[1]	μg/g	<5.89E+01	n/a	n/a	n/a	n/a
ICP.f.Tl[1]	μg/g	<4.37E+03	n/a	n/a	n/a	n/a
ICP.w.Tl[1]	μg/g	<4.15E+02	n/a	n/a	n/a	n/a

Table B3-4. 95 Percent Two-Sided Confidence Interval for the Mean Concentration for Composite Sample Data. (5 sheets)

Analyte	Units	$\hat{\mu}$	$\hat{\sigma}_{\hat{\mu}}$	df	LL	UL
ICP.a.Ti	μg/g	5.92E+01	2.55E+00	1	2.67E+01	9.16E+01
ICP.f.Ti[1]	μg/g	<2.19E+02	n/a	n/a	n/a	n/a
ICP.w.Ti[1]	μg/g	<2.08E+01	n/a	n/a	n/a	n/a
TIC	μg/g	5.86E+03	1.21E+03	1	0.00E+00	2.12E+04
TOC*	μg/g	8.55E+03	5.48E+02	1	1.60E+03	1.55E+04
ICP.a.U	μg/g	1.62E+04	1.10E+03	1	2.22E+03	3.02E+04
ICP.f.U	μg/g	3.24E+04	4.73E+03	1	0.00E+00	9.25E+04
ICP.w.U[1]	μg/g	<1.04E+03	n/a	n/a	n/a	n/a
Uranium	μg/g	1.92E+04	1.03E+03	1	6.15E+03	3.22E+04
ICP.a.V[2]	μg/g	1.64E+01	3.07E+00	1	0.00E+00	5.55E+01
ICP.f.V[1]	μg/g	<1.09E+03	n/a	n/a	n/a	n/a
ICP.w.V[1]	μg/g	<1.04E+02	n/a	n/a	n/a	n/a
ICP.a.Zn	μg/g	6.27E+01	5.30E+00	1	0.00E+00	1.30E+02
ICP.f.Zn[2]	μg/g	6.04E+02	2.01E+02	1	0.00E+00	3.16E+03
ICP.w.Zn[1]	μg/g	<3.95E+01	n/a	n/a	n/a	n/a
ICP.a.Zr	μg/g	3.38E+04	1.40E+04	1	0.00E+00	2.11E+05
ICP.f.Zr	μg/g	3.92E+04	1.72E+04	1	0.00E+00	2.57E+05
ICP.w.Zr	μg/g	3.02E+02	1.09E+02	1	0.00E+00	1.68E+03

Notes:

n/a = not applicable
* = wet basis

[1]More than 50 percent of the analytical results were less than values; therefore, confidence intervals were not computed.

[2]Some "less-than" values are in the analytical results.

In addition to core composite data, segment level data from tank 241-C-104 was also available from core 162 and core 165. The liquid sample data and solid sample data were analyzed separately. Mean concentration estimates, along with 95 percent confidence intervals on the mean, are given in Table B3-5 for the solid segment sample data and Table B3-6 for the liquid segment sample data.

Table B3-5. 95 Percent Two-Sided Confidence Interval for the Mean Concentration for Solid Segment Sample Data. (2 sheets)

Analyte	Units.	$\hat{\mu}$	$\hat{\sigma}_{\hat{\mu}}$	df	LL	UL
ICP.f.Al	μg/g	4.60E+04	1.98E+04	1	0.00E+00	2.98E+05
Am-241[1]	μCi/g	<4.72E+00	n/a	n/a	n/a	n/a
ICP.f.Sb[1]	μg/g	<1.21E+03	n/a	n/a	n/a	n/a
ICP.f.As[1]	μg/g	<2.02E+03	n/a	n/a	n/a	n/a
ICP.f.Ba[1]	μg/g	<1.01E+03	n/a	n/a	n/a	n/a
ICP.f.Be[1]	μg/g	<1.01E+02	n/a	n/a	n/a	n/a
ICP.f.Bi[1]	μg/g	<2.02E+03	n/a	n/a	n/a	n/a
ICP.f.B[1]	μg/g	<1.01E+03	n/a	n/a	n/a	n/a
Bromide[1]	μg/g	<6.48E+02	n/a	n/a	n/a	n/a
ICP.f.Cd[2]	μg/g	7.08E+02	3.50E+02	1	0.00E+00	5.16E+03
ICP.f.Ca[1]	μg/g	<2.56E+03	n/a	n/a	n/a	n/a
ICP.f.Ce[1]	μg/g	<2.02E+03	n/a	n/a	n/a	n/a
Cs-137[2]	μCi/g	6.59E+01	1.25E+01	1	0.00E+00	2.24E+02
Chloride	μg/g	4.98E+02	2.96E+01	1	1.22E+02	8.74E+02
ICP.f.Cr[2]	μg/g	1.01E+03	2.35E+02	1	0.00E+00	4.00E+03
ICP.f.Co[1]	μg/g	<4.04E+02	n/a	n/a	n/a	n/a
Co-60[1]	μCi/g	<3.40E-01	n/a	n/a	n/a	n/a
ICP.f.Cu[1]	μg/g	<3.35E+02	n/a	n/a	n/a	n/a
Eu-154[1]	μCi/g	<1.09E+00	n/a	n/a	n/a	n/a
Eu-155[1]	μCi/g	<1.14E+00	n/a	n/a	n/a	n/a
DSC	J/g	5.08E+01	1.53E+01	1	0.00E+00	1.47E+02
Fluoride	μg/g	1.54E+04	6.37E+03	1	0.00E+00	9.64E+04
Alpha	μCi/g	6.37E+00	2.63E+00	1	0.00E+00	3.98E+01
ICP.f.Fe	μg/g	2.37E+04	7.91E+03	1	0.00E+00	1.24E+05
ICP.f.La[1]	μg/g	<1.01E+03	n/a	n/a	n/a	n/a
ICP.f.Pb[1]	μg/g	<2.03E+03	n/a	n/a	n/a	n/a
ICP.f.Li[1]	μg/g	<2.02E+02	n/a	n/a	n/a	n/a
ICP.f.Mg[1]	μg/g	<2.02E+03	n/a	n/a	n/a	n/a
ICP.f.Mn[2]	μg/g	4.56E+03	1.21E+03	1	0.00E+00	1.99E+04
ICP.f.Mo[1]	μg/g	<1.01E+03	n/a	n/a	n/a	n/a
ICP.f.Nd[1]	μg/g	<2.02E+03	n/a	n/a	n/a	n/a
ICP.f.Ni	μg/g	1.70E+04	7.37E+03	1	0.00E+00	1.11E+05

Table B3-5. 95 Percent Two-Sided Confidence Interval for the Mean Concentration for Solid Segment Sample Data. (2 sheets)

Analyte	Units	$\hat{\mu}$	$\hat{\sigma}_{\hat{\mu}}$	df	LL	UL
Nitrate[2]	µg/g	1.15E+04	2.69E+03	1	0.00E+00	4.56E+04
Nitrite	µg/g	2.16E+04	4.75E+03	1	0.00E+00	8.19E+04
Oxalate	µg/g	7.08E+03	2.37E+03	1	0.00E+00	3.72E+04
% Water	%	5.08E+01	6.90E+00	1	0.00E+00	1.00E+02
Phosphate[2]	µg/g	2.26E+03	2.54E+02	1	0.00E+00	5.49E+03
ICP.f.P[1]	µg/g	<4.15E+03	n/a	n/a	n/a	n/a
ICP.f.Sm[1]	µg/g	<2.02E+03	n/a	n/a	n/a	n/a
ICP.f.Se[1]	µg/g	<2.02E+03	n/a	n/a	n/a	n/a
ICP.f.Si[2]	µg/g	6.06E+03	1.22E+03	1	0.00E+00	2.16E+04
ICP.f.Ag[2]	µg/g	3.92E+02	3.74E+01	1	0.00E+00	8.67E+02
ICP.f.Na	µg/g	1.11E+05	9.76E+03	1	0.00E+00	2.35E+05
ICP.f.Sr[1]	µg/g	<2.06E+02	n/a	n/a	n/a	n/a
Sulfate	µg/g	2.82E+03	2.58E+02	1	0.00E+00	6.09E+03
ICP.f.S[1]	µg/g	<2.02E+03	n/a	n/a	n/a	n/a
ICP.f.Tl[1]	µg/g	<4.04E+03	n/a	n/a	n/a	n/a
ICP.f.Ti[1]	µg/g	<2.11E+02	n/a	n/a	n/a	n/a
TIC	µg/g	7.01E+03	1.73E+03	1	0.00E+00	2.90E+04
TOC*	µg/g	1.01E+04	1.57E+03	1	0.00E+00	3.01E+04
ICP.f.U[2]	µg/g	2.12E+04	3.07E+03	1	0.00E+00	6.02E+04
ICP.f.V[1]	µg/g	<1.01E+03	n/a	n/a	n/a	n/a
ICP.f.Zn[1]	µg/g	<2.51E+02	n/a	n/a	n/a	n/a
ICP.f.Zr[2]	µg/g	3.47E+04	1.49E+04	1	0.00E+00	2.24E+05
Bulk density	g/mL	1.69E+00	4.78E-02	1	1.08E+00	2.30E+00

Notes:

n/a = not applicable
* = wet basis

[1]More than 50 percent of the analytical results were less than values; therefore, confidence intervals were not computed.

[2]Some "less-than" values are in the analytical results.

Table B3-6. 95 Percent Two-Sided Confidence Interval for the Mean Concentration for Liquid Segment Sample Data. (2 sheets)

Analyte	Units	$\hat{\mu}$	$\hat{\sigma}_{\hat{\mu}}$	df	LL	UL
Al	μg/mL	1.29E+03	4.75E+01	1	6.84E+02	1.89E+03
Sb[1]	μg/mL	<1.21E+01	n/a	n/a	n/a	n/a
As[1]	μg/mL	<2.01E+01	n/a	n/a	n/a	n/a
Ba[1]	μg/mL	<1.01E+01	n/a	n/a	n/a	n/a
Be[1]	μg/mL	<1.01E+00	n/a	n/a	n/a	n/a
Bi[1]	μg/mL	<2.01E+01	n/a	n/a	n/a	n/a
Bromide[1]	μg/mL	<2.02E+02	n/a	n/a	n/a	n/a
Cd	μg/mL	7.68E+00	1.58E+00	1	0.00E+00	2.77E+01
Ca[1]	μg/mL	<2.01E+01	n/a	n/a	n/a	n/a
Ce[1]	μg/mL	<2.01E+01	n/a	n/a	n/a	n/a
Chloride	μg/mL	1.26E+03	3.73E+02	1	0.00E+00	6.00E+03
Cr	μg/mL	9.49E+00	1.46E+00	1	0.00E+00	2.81E+01
Co[1]	μg/mL	<4.02E+00	n/a	n/a	n/a	n/a
Cu	μg/mL	1.17E+01	2.50E-02	1	1.14E+01	1.20E+01
DSC	J/g	2.57E+02	1.16E+02	1	0.00E+00	9.89E+02
Fluoride	μg/mL	8.22E+03	1.72E+03	1	0.00E+00	3.01E+04
Alpha[1]	μCi/mL	<1.27E-03	n/a	n/a	n/a	n/a
Fe[1]	μg/mL	<1.01E+01	n/a	n/a	n/a	n/a
La[1]	μg/mL	<1.01E+01	n/a	n/a	n/a	n/a
Pb[1]	μg/mL	<2.01E+01	n/a	n/a	n/a	n/a
Li[1]	μg/mL	<2.01E+00	n/a	n/a	n/a	n/a
Mg[1]	μg/mL	<2.01E+01	n/a	n/a	n/a	n/a
Mn[1]	μg/mL	<2.01E+00	n/a	n/a	n/a	n/a
Mo[1]	μg/mL	<1.01E+01	n/a	n/a	n/a	n/a
Nd[1]	μg/mL	<2.01E+01	n/a	n/a	n/a	n/a
Ni	μg/mL	6.48E+01	7.17E+00	1	0.00E+00	1.56E+02
Nitrate	μg/mL	4.03E+04	1.55E+04	1	0.00E+00	2.38E+05
Nitrite	μg/mL	4.66E+04	1.18E+04	1	0.00E+00	1.97E+05
Oxalate	μg/mL	2.28E+03	2.24E+02	1	0.00E+00	5.12E+03
% Water	%	8.08E+01	7.90E-01	1	7.08E+01	9.08E+01

Table B3-6. 95 Percent Two-Sided Confidence Interval for the Mean Concentration for Liquid Segment Sample Data. (2 sheets)

Analyte	Units	$\hat{\mu}$	$\hat{\sigma}_{\hat{\mu}}$	df	LL	UL
Phosphate	μg/mL	3.97E+03	2.14E+03	1	0.00E+00	3.12E+04
P	μg/mL	1.07E+03	4.25E+01	1	5.27E+02	1.61E+03
K	μg/mL	6.15E+02	5.35E+01	1	0.00E+00	1.29E+03
Sm[1]	μg/mL	<2.01E+01	n/a	n/a	n/a	n/a
Se[2]	μg/mL	2.29E+01	1.73E+00	1	9.57E-01	4.48E+01
Si	μg/mL	1.39E+02	5.35E+01	1	0.00E+00	8.18E+02
Ag	μg/mL	5.48E+00	9.25E-02	1	4.30E+00	6.65E+00
Na	μg/mL	7.26E+04	1.95E+03	1	4.78E+04	9.74E+04
Specific gravity	----	1.12E+00	2.48E-02	1	8.02E-01	1.43E+00
Sr[1]	μg/mL	<2.01E+00	n/a	n/a	n/a	n/a
Sulfate	μg/mL	6.05E+03	2.24E+03	1	0.00E+00	3.45E+04
S	μg/mL	1.42E+03	1.75E+01	1	1.20E+03	1.64E+03
Tl[1]	μg/mL	<4.02E+01	n/a	n/a	n/a	n/a
Ti[1]	μg/mL	<2.01E+00	n/a	n/a	n/a	n/a
TIC	μg/mL	6.62E+03	1.12E+03	1	0.00E+00	2.09E+04
TOC*	μg/mL	5.14E+03	6.58E+02	1	0.00E+00	1.35E+04
U[1]	μg/mL	<1.00E+02	n/a	n/a	n/a	n/a
V[1]	μg/mL	<1.01E+01	n/a	n/a	n/a	n/a
Zn	μg/mL	1.26E+01	1.33E+00	1	0.00E+00	2.94E+01
Zr[1]	μg/mL	<2.01E+00	n/a	n/a	n/a	n/a

Notes:

n/a = not applicable
* = wet basis

[1]More than 50 percent of the analytical results were less than values; therefore, confidence intervals were not computed.

[2]Some "less-than" values are in the analytical results.

B3.4.2 Analysis of Variance Models

A statistical model is needed to account for the spatial and measurement variability in $\hat{\sigma}_{\hat{\mu}}$. This cannot be done using an ordinary standard deviation of the data (Snedecor et al. 1980).

The statistical model fit to the composite sample data is

$$Y_{ij} = \mu + C_i + A_{ij},$$

$$i = 1,\ldots,a,\ j = 1,\ldots,b_i,$$

where

Y_{ij}	=	laboratory results from the j^{th} duplicate from the i^{th} core in the tank
μ	=	the grand mean
C_i	=	the effect of the i^{th} core
A_{ij}	=	the effect of the j^{th} analytical result from the i^{th} core
a	=	the number of cores
b_i	=	the number of analytical results from the i^{th} core

The variable C_i is assumed to be a random effect. This variable and A_{ij} are assumed to be uncorrelated and normally distributed with means zero and variances $\sigma^2(C)$ and $\sigma^2(A)$, respectively. Estimates of $\sigma^2(C)$ and $\sigma^2(A)$ were obtained using Restricted Maximum Likelihood Estimation (REML) techniques. This method, applied to variance component estimation, is described in Harville (1977). The statistical results were obtained using the statistical analysis package S-PLUS[6] (Statistical Sciences 1993).

The statistical model fit to the solid segment sample data is

$$Y_{ijkm} = \mu + C_i + S_{ij} + L_{ijk} + A_{ijkm},$$

$$i = 1,\ldots,a,\ j = 1,\ldots,b_i,\ k = 1,\ldots,c_{ij},\ m = 1,\ldots,d_{ijk},$$

[6]S-PLUS is a trademark of Statistical Sciences, Incorporated, Seattle, Washington.

where

Y_{ijkm}	=	laboratory results from the m^{th} duplicate in the k^{th} location in the j^{th} segment in the i^{th} core in the tank,
μ	=	the grand mean
C_i	=	the effect of the i^{th} core
S_{ij}	=	the effect of the j^{th} segment from the i^{th} core
L_{ijk}	=	the effect of the k^{th} location in the j^{th} segment in the i^{th} core
A_{ijkm}	=	the effect of the m^{th} analytical result from the k^{th} location in the j^{th} segment in the i^{th} core
a	=	the number of cores
b_i	=	the number of segments in the i^{th} core
c_{ij}	=	the number of locations from the j^{th} segment in the i^{th} core
d_{ijk}	=	the number of analytical results from the k^{th} location in the j^{th} segment in the i^{th} core

The variable C_i, S_{ij}, and L_{ijk} are assumed to be random effects. These variables and A_{ijkm} are assumed to be uncorrelated and normally distributed with means zero and variances $\sigma^2(C)$, $\sigma^2(S)$, $\sigma^2(L)$, and $\sigma^2(A)$, respectively. Estimates of $\sigma^2(C)$, $\sigma^2(S)$, $\sigma^2(L)$, and $\sigma^2(A)$ were obtained using restricted maximum likelihood estimation (REML) techniques. This method, applied to variance component estimation, is described in Harville (1977). The statistical results were obtained using statistical analysis package S-PLUS™.

The statistical model fit to the liquid segment sample data is

$$Y_{ij} = \mu + S_i + A_{ij},$$

$$i = 1,\ldots,a,\ j = 1,\ldots,b_i,$$

where

Y_{ij} = laboratory results from the j^{th} duplicate from the i^{th} segment in the tank

μ = the grand mean

Si = the effect of the i^{th} segment

Aij = the effect of the j^{th} analytical result from the i^{th} segment

a = the number of segments

b_i = the number of analytical results from the i^{th} segment

The variable S_i is assumed to be a random effect. This variable and A_{ij} are assumed to be uncorrelated and normally distributed with means zero and variances $\sigma^2(S)$ and $\sigma^2(A)$, respectively. Estimates of $\sigma^2(S)$ and $\sigma^2(A)$ were obtained using Restricted Maximum likelihood Estimation (REML) techniques. This method, applied to variance component estimation, is described in Harville (1977). The statistical results were obtained using the statistical analysis package S-PLUS™.

B4.0 APPENDIX B REFERENCES

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APPENDIX C

STATISTICAL ANALYSIS FOR ISSUE RESOLUTION

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C1.0 STATISTICS FOR SAFETY SCREENING DATA QUALITY OBJECTIVE

The safety screening DQO (Dukelow et al. 1995) defines acceptable decision confidence limits in terms of one-sided 95 percent confidence intervals. In this appendix, one-sided confidence limits supporting the safety screening DQO are calculated for tank 241-C-104. All data in this section are from the final laboratory data package for the 1996 core sampling event for tank 241-C-104 (Fritts 1996).

Confidence intervals were computed for each sample number from tank 241-C-104 analytical data. The sample numbers and confidence intervals are provided in Table C1-1 for DSC and Table C1-2 for Alpha.

The upper limit (UL) of a one-sided 95 percent confidence interval on the mean is $\hat{\mu} + t_{(df,0.05)} * \hat{\sigma}_{\hat{\mu}}$.

In this equation, $\hat{\mu}$ is the arithmetic mean of the data, $\hat{\sigma}_{\hat{\mu}}$ is the estimate of the standard deviation of the mean, and $t_{(df,0.05)}$ is the quantile from Student's t distribution with df degrees of freedom for a one-sided 95 percent confidence interval.

For the tank 241-C-104 data per sample number, df equals the number of observations minus one.

The upper limit of the 95 percent confidence interval for each sample number based on alpha data is listed in Table C1-1. Each confidence interval can be used to make the following statement. If the upper limit is less than 36 μCi/g (61.5 μCi/mL for drainable liquid), then one would reject the null hypothesis that the alpha is greater than or equal to 41 μCi/g (61.5 μCi/mL for drainable liquid) at the 0.05 level of significance. One sample exceeded the 95 percent confidence interval upper level for total alpha of 36 μCi/g. A measurement of Pu for the sample showed the Pu to be well below the threshold limit.

The upper limit of the 95 percent confidence interval for each sample number based on DSC data is listed in Table C1-2. Each confidence interval can be used to make the following statement. If the upper limit is less than 480 J/g, then one would reject the null hypothesis that DSC is greater than or equal to 480 J/g at the 0.05 level of significance. As shown in Table C1-2, one sample (drainable liquid) exceeded the 95 percent confidence interval upper limit for DSC of 480 J/g on a dry weight basis. The percent water for this same sample (80 percent) indicates there is sufficient water to prevent a propagating reaction.

Table C1-1. 95 Percent Confidence Interval Upper Limits for Alpha for Tank 241-C-104 (Units are μCi/g or μCi/mL).

Sample Number	Sample Description	$\hat{\mu}$	$\hat{\sigma}_{\hat{\mu}}$	UL
S96T004363	Core 162, segment 3, drainable liquid	1.72E-03	1.65E-04	2.76E-03
S96T004368	Core 162, segment 3, lower half	5.62E+00	1.10E-01	6.31E+00
S96T004380	Core 165, segment 1, lower half	7.42E+00	2.85E-01	9.21E+00
S96T004381	Core 165, segment 2, lower half	1.41E+01	3.00E-01	1.60E+01
S96T004828	Core 162, segment 4, drainable liquid	8.17E-04	3.03E-04	2.73E-03
S96T004853	Core 162, segment 1, lower half	2.30E+00	8.50E-02	2.83E+00
S96T004854	Core 162, segment 2, lower half	3.23E+00	2.50E-02	3.38E+00
S96T004855	Core 162, segment 4, lower half	1.08E+00	1.07E-01	1.76E+00
S96T004889	Core 165, segment 3, qtr. A	3.36E+00	6.50E-02	3.77E+00
S96T004893	Core 165, segment 3, qtr. B	3.84E+01	1.55E+00	4.81E+01
S96T004894	Core 165, segment 3, qtr. C	3.19E+00	1.00E-02	3.25E+00
S96T004895	Core 165, segment 4, qtr. B	1.63E+00	2.00E-02	1.76E+00
S96T004896	Core 165, segment 4, qtr. C	4.65E+00	2.35E-01	6.13E+00
S96T004897	Core 165, segment 6, qtr. C	6.18E-01	4.90E-02	9.27E-01
S96T004898	Core 165, segment 6, qtr. D	9.75E-01	5.50E-02	1.32E+00
S96T004924	Core 165, segment 5, lower half	2.74E+00	2.15E-01	4.09E+00

Table C1-2. 95 Percent Confidence Interval Upper Limits for DSC for Tank 241-C-104 (Units are J/g-Dry).

Sample Number	Sample Description	$\hat{\mu}$	$\hat{\sigma}_{\hat{\mu}}$	UL
S96T004358	Core 162, segment 3, upper half	0.00E+00	0.00E+00	0.00E+00
S96T004363	Core 162, segment 3, drainable liquid	3.73E+02	3.75E+01	6.09E+02
S96T004366	Core 162, segment 3, lower half	7.55E+01	5.75E+00	1.12E+02
S96T004371	Core 165, segment 2, upper half	0.00E+00	0.00E+00	0.00E+00
S96T004379	Core 165, segment 2, lower half	0.00E+00	0.00E+00	0.00E+00
S96T004828	Core 162, segment 4, drainable liquid	1.41E+02	1.95E+01	2.64E+02
S96T004838	Core 162, segment 1, upper half	0.00E+00	0.00E+00	0.00E+00
S96T004839	Core 162, segment 2, upper half	3.28E+01	4.05E+00	5.83E+01
S96T004840	Core 162, segment 4, upper half	0.00E+00	0.00E+00	0.00E+00
S96T004841	Core 162, segment 1, lower half	9.39E+01	1.02E+01	1.58E+02
S96T004842	Core 162, segment 2, lower half	8.06E+01	3.15E+01	2.79E+02
S96T004843	Core 162, segment 4, lower half	0.00E+00	0.00E+00	0.00E+00
S96T004872	Core 165, segment 3, qtr. A	5.67E+01	4.00E-01	5.92E+01
S96T004873	Core 165, segment 3, qtr. B	9.50E+01	1.00E+01	1.58E+02
S96T004874	Core 165, segment 3, qtr. C	0.00E+00	0.00E+00	0.00E+00
S96T004875	Core 165, segment 4, qtr. A	0.00E+00	0.00E+00	0.00E+00
S96T004876	Core 165, segment 4, qtr. B	6.63E+01	1.97E+01	1.91E+02
S96T004877	Core 165, segment 4, qtr. C	1.67E+02	4.00E+00	1.92E+02
S96T004878	Core 165, segment 6, qtr. A	8.42E+01	2.39E+01	2.35E+02
S96T004879	Core 165, segment 6, qtr. B	1.17E+02	5.71E+01	4.77E+02
S96T004880	Core 165, segment 6, qtr. C	0.00E+00	0.00E+00	0.00E+00
S96T004881	Core 165, segment 6, qtr. D	0.00E+00	0.00E+00	0.00E+00
S96T004919	Core 165, segment 5, upper half	2.88E+02	3.69E+01	3.75E+02
S96T004920	Core 165, segment 5, lower half	0.00E+00	0.00E+00	0.00E+00
S96T005360	Core 165, segment 1, lower half	0.00E+00	0.00E+00	0.00E+00

C1.1 STATISTICS FOR THE ORGANIC DQO

The organic DQO (Turner et al. 1995) defines acceptable decision confidence limits in terms of one-sided 95 percent confidence intervals. In this appendix, one-sided confidence limits supporting the organic DQO are calculated for tank 241-C-104. All data considered in this section are taken from the final laboratory data package for the 1996 core sampling event for tank 241-C-104 (Fritts 1996).

Confidence intervals were computed for each sample number from tank 241-C-104 analytical data. The sample numbers and confidence intervals are provided in Table C1-3 for percent water and Table C1-4 for TOC.

For percent water, the lower limit (LL) of a one-sided 95 percent confidence interval for the mean is

$$\hat{\mu} - t_{(df,0.05)} * \hat{\sigma}_{\hat{\mu}}$$

and for TOC, the upper limit (UL) of a one-sided 95 percent confidence interval for the mean is

$$\hat{\mu} + t_{(df,0.05)} * \hat{\sigma}_{\hat{\mu}}.$$

For these equations, $\hat{\mu}$ is the arithmetic mean of the data, $\hat{\sigma}_{\hat{\mu}}$ is the estimate of the standard deviation of the mean, and $t_{(df,0.05)}$ is the quantile from Student's t distribution with df degrees of freedom for a one-sided 95 percent confidence interval.

For the tank 241-C-104 data (per sample number), df equals the number of observations minus one.

The lower limit of the 95 percent confidence interval for each sample number based on percent water data is listed in Table C1-3. Each confidence interval can be used to make the following statement. If the lower limit is greater than 17 percent, then one would reject the null hypothesis that the percent water is less than or equal to 17 percent at the 0.05 level of significance. Three samples have percent water less than the lower limit of the 95 percent confidence interval. The DSC for these samples was less than 480 J/g, however, so the low percent moisture is not a safety concern.

The upper limit of the 95 percent confidence interval for each sample number based on TOC data is listed in Table C1-4. Each confidence interval can be used to make the following statement. If the upper limit is less than 30,000 μg/g dry, then one would reject the null hypothesis that TOC is greater than or equal to 30,000 μg/g at the 0.05 level of significance. The units for TOC drainable liquid samples were converted from μg/mL to μg/g using the specific gravity results for each sample number. All samples were below the upper limit of the 95 percent confidence interval limit of 30,000 μg/g.

Table C1-3. 95 Percent Confidence Interval Lower Limits for Percent Water for Tank 241-C-104 (Units are in %).

Sample Number	Sample Description	$\hat{\mu}$	$\hat{\sigma}_{\hat{\mu}}$	LL
S96T004358	Core 162, segment 3, upper half	4.59E+01	3.00E-01	4.40E+01
S96T004363	Core 162, segment 3, drainable liquid	8.00E+01	2.90E-01	7.82E+01
S96T004366	Core 162, segment 3, lower half	5.02E+01	2.73E+00	3.30E+01
S96T004371	Core 165, segment 2, upper half	4.84E+01	2.30E+00	3.39E+01
S96T004379	Core 165, segment 2, lower half	5.81E+01	1.80E+00	4.67E+01
S96T004828	Core 162, segment 4, drainable liquid	8.16E+01	4.00E-01	7.91E+01
S96T004838	Core 162, segment 1, upper half	4.19E+01	4.09E+00	1.60E+01
S96T004839	Core 162, segment 2, upper half	4.81E+01	3.35E+00	2.69E+01
S96T004840	Core 162, segment 4, upper half	2.48E+01	9.50E-01	1.88E+01
S96T004841	Core 162, segment 1, lower half	4.72E+01	6.57E+00	5.68E+00
S96T004842	Core 162, segment 2, lower half	5.15E+01	9.30E-01	4.56E+01
S96T004843	Core 162, segment 4, lower half	3.79E+01	1.22E+01	9.16E+00
S96T004872	Core 165, segment 3, qtr. A	6.18E+01	1.80E-01	6.07E+01
S96T004873	Core 165, segment 3, qtr. B	6.55E+01	6.51E+00	2.44E+01
S96T004874	Core 165, segment 3, qtr. C	6.12E+01	1.57E+00	5.13E+01
S96T004875	Core 165, segment 4, qtr. A	5.50E+01	5.55E+00	2.00E+01
S96T004876	Core 165, segment 4, qtr. B	6.14E+01	1.80E-01	6.03E+01
S96T004877	Core 165, segment 4, qtr. C	4.99E+01	3.97E+00	2.48E+01
S96T004878	Core 165, segment 6, qtr. A	6.22E+01	1.03E+00	5.57E+01
S96T004879	Core 165, segment 6, qtr. B	5.88E+01	1.00E-02	5.87E+01
S96T004880	Core 165, segment 6, qtr. C	7.59E+01	3.19E+00	5.57E+01
S96T004881	Core 165, segment 6, qtr. D	8.08E+01	2.40E-01	7.93E+01
S96T004919	Core 165, segment 5, upper half	5.47E+01	2.65E-01	5.30E+01
S96T004920	Core 165, segment 5, lower half	6.21E+01	2.00E-01	6.08E+01
S96T005360	Core 165, segment 1, lower half	3.88E+01	2.50E-02	3.86E+01

Table C1-4. 95 Percent Confidence Interval Upper Limits for TOC for Tank 241-C-104 (Units are in μg/g-Dry).

Sample Number	Sample Description	$\hat{\mu}$	$\hat{\sigma}_{\hat{\mu}}$	UL
S96T004358	Core 162, segment 3, upper half	2.39E+04	2.77E+02	2.57E+04
S96T004363	Core 162, segment 3, drainable liquid	2.52E+04	2.14E+03	3.89E+04
S96T004366	Core 162, segment 3, lower half	2.43E+04	6.03E+02	2.81E+04
S96T004371	Core 165, segment 2, upper half	2.70E+04	2.91E+02	2.89E+04
S96T004379	Core 165, segment 2, lower half	2.21E+04	1.99E+03	3.47E+04
S96T004828	Core 162, segment 4, drainable liquid	1.97E+04	4.97E+01	2.00E+04
S96T004838	Core 162, segment 1, upper half	1.81E+04	2.58E+02	1.98E+04
S96T004839	Core 162, segment 2, upper half	3.78E+04	9.63E+02	4.38E+04
S96T004840	Core 162, segment 4, upper half	2.29E+03	1.93E+02	3.51E+03
S96T004841	Core 162, segment 1, lower half	1.99E+04	7.57E+02	2.47E+04
S96T004842	Core 162, segment 2, lower half	2.11E+04	3.09E+02	2.31E+04
S96T004843	Core 162, segment 4, lower half	2.32E+03	1.77E+02	3.44E+03
S96T004872	Core 165, segment 3, qtr. A	2.33E+04	1.49E+03	3.27E+04
S96T004873	Core 165, segment 3, qtr. B	2.92E+04	9.87E+02	3.54E+04
S96T004874	Core 165, segment 3, qtr. C	1.61E+04	3.22E+02	1.81E+04
S96T004875	Core 165, segment 4, qtr. A	1.54E+04	5.00E+02	1.85E+04
S96T004876	Core 165, segment 4, qtr. B	2.25E+04	1.06E+03	2.92E+04
S96T004877	Core 165, segment 4, qtr. C	6.30E+04	1.30E+03	7.11E+04
S96T004878	Core 165, segment 6, qtr. A	1.33E+04	2.25E+02	1.47E+04
S96T004879	Core 165, segment 6, qtr. B	2.09E+04	1.21E+01	2.10E+04
S96T004880	Core 165, segment 6, qtr. C	1.04E+04	7.45E+02	1.51E+04
S96T004881	Core 165, segment 6, qtr. D	1.15E+04	1.12E+03	1.85E+04
S96T004919	Core 165, segment 5, upper half	3.30E+04	5.51E+02	3.65E+04
S96T004920	Core 165, segment 5, lower half	3.88E+04	2.64E+02	4.05E+04
S96T005966	Core 165, segment 1, lower half	1.35E+04	1.28E+03	2.16E+04

C2.0 APPENDIX C REFERENCES

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APPENDIX D

EVALUATION TO ESTABLISH BEST-BASIS STANDARD INVENTORY FOR TANK 241-C-104

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APPENDIX D

EVALUATION TO ESTABLISH BEST-BASIS INVENTORY FOR SINGLE-SHELL TANK 241-C-104

An effort is underway to provide waste inventory estimates that will serve as standard characterization source terms for the various waste management activities (Hodgson and LeClair 1996). As part of this effort, an evaluation of available information for tank 241-C-104 was performed, and a best-basis inventory was established. This work, detailed in the following sections, follows the methodology that was established by the standard inventory task.

D1.0 CHEMICAL INFORMATION SOURCES

This section describes the sampling campaigns that have been performed to establish the waste composition profiles in tank 241-C-104. In July, 1996, two push mode core samples were obtained from risers 3 and 14 of tank 241-C-104. Core 162 from riser 3 contained 4 segments, with the top of first segment located approximately 63.5 cm (25 in.) below the anticipated top of the sludge surface and the bottom of segment 4 about 2.54 cm (1 in.) above the bottom of the tank due to an undocumented offset in the elevation of the riser spool. The second core, core 165 from riser 14, was a full-depth core consisting of 6 segments.

These samples were analyzed for chemical and radionuclide composition of the waste. Various sample preparation methods were used, including water, acid, and potassium hydroxide (KOH) fusion digestions to dissolve the solids. Analyses performed included ICP analysis of metals, IC analysis of anions, GEA, AEA and mass spectroscopy for analysis of radionuclides. Analyte recoveries were verified by means of laboratory control samples, carriers, tracers, and surrogates that were analyzed concurrently with the samples. Other laboratory tests included TGA, DSC, specific gravity, TOC and percent moisture analysis. Analyte concentrations from core segments and core composites were statistically analyzed to establish mean values for each analyte.

A third core sample was also obtained from riser 8 in April, 1986. This core consisted of 6 segments which were combined to generate a composite sample for chemical and radionuclide analysis of the waste (Weiss and Schull 1988). Metals and radionuclides were analytically measured after water digestion of the original sample, acid digestion of the acid insoluble residue and strong acid (HNO_3-HF-HCl) digestion of the acid insoluble fraction. All of the acid insoluble residue was dissolved. Metals were determined by ICP, while anions were measured by IC.

The waste history of this tank is provided in other references (Anderson 1990). Tank 241-C-104 was removed from service in 1980, partially isolated in 1982, and salt well pumped on various occasions until 1989 (with only a minimal amount of salt well pumping after 1986). The 1986 and two 1996 core samples are considered to be representative of the current inventory in the tank. Component inventories can be calculated by multiplying the mean concentration of an analyte by the appropriate volume and density of the sludge and liquid layers in the tank. The HDW model (Agnew et al. 1996) also provides an independent set of estimates for component inventories in this tank.

D2.0 COMPARISON OF COMPONENT INVENTORY VALUES

The 1986 core and one of the 1996 cores (core 165) contained 6 segments each, while the other 1996 core (core 162) is comprised of 4 segments. Table D2-1 provides data on the segment recoveries from the cores together with the projected depth of the sludge layer based on the physical dimensions of the sampler. Each segment is 48.3 cm (19 in.) long, 2.54 cm (1 in.) in diameter, and has a maximum volume of 244.5 cm^3 (14.9 $in.^3$).

Segment recoveries were identified as percent recovered based on the theoretical volume of the sampler. These cores show that the average sludge depth beneath the risers is about 253.6 cm (99.8 in.), which is higher than the measured depth of 221.7 cm (87.3 in.) as of January, 1993 (Swaney 1993) but slightly lower than the 260.9 cm (102.7 in.) depth cited by Hanlon in the Waste Status Summary Report (Hanlon 1997).

Table D2-1. Core Segment Recoveries and Sludge Layer Depth Estimates for Tank 241-C-104. (2 sheets)

Date	Riser	Core	Segment	Percent Recovered	Percent Solids	Percent Liquids	Segment Depth cm (in.)
1986	8	-	1	32	100	0	15.2 (6)
			2	100	100	0	48.3 (19)
			3	100	100	0	48.3 (19)
			4	100	100	0	48.3 (19)
			5	100	100	0	48.3 (19)
			6	100	97	3	48.3 (19)
						Total	256.7 (101)
1996	3	162	1	92	100	0	48.3[1] (19)[1]
			2	97	100	0	48.3[1] (19)[1]

Table D2-1. Core Segment Recoveries and Sludge Layer Depth Estimates for Tank 241-C-104. (2 sheets)

Date	Riser	Core	Segment	Percent Recovered	Percent Solids	Percent Liquids	Segment Depth cm (in.)
			3	100	89	11	48.3[1] (19)[1]
			4	92	89	11	48.3[1] (19)[1]
						Total	193.2[1] (76)[1]
1996	14	165	1	18	100	0	8.9 (3.5)
			2	100	100	0	48.3 (19)
			3	100	100	0	48.3 (19)
			4	100	100	0	48.3 (19)
			5	89	100	0	48.3 (19)
			6	95	100	0	48.3 (19)
						Total	250.4 (98.5)

Notes:

[1]Core 162 does not appear to have been a full-depth core.

Based on the average sludge level (of 253.6 cm [99.84 in.]) obtained from the core samples, tank 241-C-104 apparently contains about 1,087.6 kL (287.3 kgal) of waste, including 45.9 kL (12.1 kgal) because of the dished bottom configuration of the 22.86 m (75 ft) diameter tank. All of this waste consists of sludge. This inventory estimate is about 2.8 percent lower than the tank farm surveillance estimate of 1,116 kL (295 kgal) (Hanlon 1997). Because these values are relatively close, the tank farm surveillance estimate will be used in this analysis for the best-basis inventory.

Table D2-2 provides a summary of the composite sludge analytical results and tank inventory estimates based on the waste volume and solid segment sample density data (1,116 kL [295 kgal] and 1.69 kg/L, respectively, for the 1996 cores, and a density of 1.21 kg/L for the 1986 core). Liquid sample data was not used in estimating component inventories because only a minimal amount of liquid was found in the tank (17 kL of interstitial liquid). Because of the segment breakdown protocol and more complete analysis of the 1996 cores, including KOH fusion and statistical analysis of the analytes, the 1996 cores will be used as the basis for the tank inventory estimates in Table D2-2.

Table D2-2. Analytical Results and Sludge Inventory Estimates for Nonradioactive Components in Tank 241-C-104. (2 sheets)

Component	Mean Sludge Concentration in 1986 Core[1] (μg/g)	Mean Sludge Concentration in 1996 Cores[2] (μg/g)	Total Tank Inventory[3] (kg)
Al	30,100	54,400	103,000
Sb	n/r	<1,310	<2,470
As	n/r	<2,190	<4,120
Ba	3,900	<1,090	<2,060
Be	n/r	<109	<206
Bi	3,640	<2,190	<4,120
B	17.1	1,080	2,040
Cd	1,280	620	1,170
Ca	11,300	<2,190	<4,120
Ce	n/r	<2,190	<4,120
Cl	n/r	483	911
Cr	1,120	882	1,660
Co	16.2	<437	<824
Cu	112	<219	<412
F	n/r	20,900	39,400
Fe	26,100	16,700	31,400
La	n/r	<1,090	<2,060
Pb	818	<2,190	<4,120
Li	n/r	<219	<412
Mg	5,460	<2,190	<4,120
Mn	3,280	4,240	7,990
Mo	n/r	<1,090	<2,060
Nd	n/r	<2,190	<4,120
Ni	1,910	1,590[4]	3,000[4]
NO_3	23,400	11,800	22,300
NO_2	n/r	22,000	41,600
C_2O_6	n/r	3,390	6,390
P as PO_4	9,590	3,126	5,915
K	1,350	804	1,520

Table D2-2. Analytical Results and Sludge Inventory Estimates for Nonradioactive Components in Tank 241-C-104. (2 sheets)

Component	Mean Sludge Concentration in 1986 Core[1] (μg/g)	Mean Sludge Concentration in 1996 Cores[2] (μg/g)	Total Tank Inventory[3] (kg)
Sm	n/r	<2,190	<4,120
Se	n/r	<2,190	<4,120
Si	56,400	6,180	11,600
Ag	468	637	1,200
Na	95,500	108,000	203,000
Sr	81.2	<219	<412
SO_4	n/r	<6,570	<12,360
Tl	n/r	<4,370	<8,240
Ti	n/r	<219	<412
TIC as CO_3	n/r	29,300	55,000
TOC	4,410	8,550	16,100
U	16,100	32,400	61,100
V	n/r	<1,090	<2,060
Zn	117	604	1,140
Zr	61,800	39,200	73,900
Density	1.21 g/mL	1.69 g/mL	

Notes:

n/r = not reported

[1]Mean sludge concentrations for 1986 core from Weiss and Schull (1988).

[2]Mean sludge concentrations from 1996 sampling event for cores 162 and 165.

[3]Tank inventory based on 1,116 kL of sludge with an average density of 1.69 kg/L. The 1996 mean sludge concentrations were used.

[4]Because nickel crucibles were used in the KOH fusion, Ni results are based on acid digestion.

Table D2-3 provides a summary of the mean composite sludge radionuclide concentrations and tank inventory estimates based on the 1986 and two 1996 core samples. Radionuclide results in Table D-3 are reported as mean values and have been decayed to January 1, 1994. Original analytical values may be referenced in Weiss and Schull (1988) and in Appendix B.

Table D2-3. Analytical Results and Tank Inventory Estimates for Radioactive Components in Tank 241-C-104 (Tank Inventory Only Decayed to January 1, 1994, Except Total Alpha, Beta and Gamma).

Radionuclide	1986 core[1] (μCi/g)	1996 cores[2] (μCi/g)	Tank inventory[3] (Ci)
^{14}C	6.22E-04	n/r	1.17
^{60}Co	0.195	0.323	610
^{90}Sr	306	323	624,000
^{99}Tc	2.77	n/r	5,224
^{129}I	0	n/r	n/r
^{137}Cs	26.1	65	123,000
^{154}Eu	n/r	1.0	1,880
^{155}Eu	n/r	<0.185	<1,850
$^{239/240}Pu$	2.96	n/r	5,827
^{241}Am	3.11	3.79	7,153
Total Alpha	n/r	6.37	12,000
Total Beta	n/r	642	1.21E+06
Total Gamma	48.4	3.76	7,090

Notes:

n/r = not reported

[1]Based on decayed mean of 1986 core sample sludge (Weiss and Schull 1988).

[2]Based on decayed mean of 1996 core samples.

[3]Tank inventory based on 1,116 kL (295 kgal) of sludge with a density of 1.69 kg/L and all radionuclide values decayed to January 1, 1994. The 1996 mean sludge concentrations were used when available. In instances where the 1996 mean sludge concentration was not available, the 1986 mean sludge concentration was used.

D3.0 COMPONENT INVENTORY EVALUATION

Sample-based estimates developed from analytical data and HDW model estimates from LANL (Agnew et al. 1996) are both potentially useful for estimating component inventories in the tank. The HDW model is mainly based on process production records and waste transaction records for each tank. Primary wastes are process wastes initially added to tank 241-C-104, while secondary wastes are those transferred from another tank. A review of these records shows that tank 241-C-104 received the following wastes (Agnew et al. 1996):

- 6,018 kL (1,590 kgal) of primary $BiPO_4$ metal waste (MW), all of which was later sluiced for Uranium Recovery (UR).
- 18,993 kL (5,018 kgal) of primary plutonium uranium extraction (PUREX) process coating waste (CWP1, CWP2).
- 2,358 kL (623 kgal) of primary PUREX process zirconium coating (CWP/Zr) waste.
- 340 kL (90 kgal) of primary process decontamination (DW) waste.
- 19,542 kL (5,163 kgal) of primary PUREX process organic wash (OWW3) waste
- 1,563 kL (413 kgal) of primary thoria high-level (TH) waste.
- 1,889 kL (499 kgal) of primary thoria low-level (THL) waste.
- 344 kL (91 kgal) of primary PUREX process high-level waste (1968-1972) (P).
- 1,790 kL (473 kgal) of primary PUREX process low-level (PL) waste.
- Plus a substantial volume of secondary wastes (supernatants) from uranium recovery, hot semi-works, PUREX process coating wastes and a variety of other processes.

The HDW model (Agnew et al. 1996) assumes that 1,116 kL (295 kgal) of sludge have accumulated in tank 241-C-104, broken down as follows:

- 11.3 kL (3 kgal) of $BiPO_4$ metal waste (MW) sludge.
- 632 kL (167 kgal) of PUREX process coating waste (CWP1 and CWP2) sludge.

- 102 kL (27 kgal) of PUREX process zirconium coating waste (CWP/Zr) sludge.
- 91 kL (24 kgal) of thoria high-level waste (TH) sludge.
- 38 kL (10 kgal) of PUREX process low-level waste (PL) sludge.
- 117 kL (31 kgal) of PUREX process organic wash waste (OWW3) sludge.
- 8 kL (2 kgal) of PUREX process high-level waste (P2) sludge.
- 57 kL (15 kgal) of unknown sludge designated as reduction and oxidation process coating waste (CWR2).
- 42 kL (11 kgal) of unknown sludge assumed to be to SRR.
- 19 kL (5 kgal) of unknown sludge designated as 242-A evaporator concentrates (SMMA1).

These estimates do not include any secondary wastes, such as secondary UR, HS, CWP1 or PUREX process wastes that might have settled in tank 241-C-104. Usually, the combinations of secondary wastes can be safely ignored because 80 to 90 percent of the solids in these wastes are likely to have settled in the primary receiver tanks. In the 241-TY-105 and 241-TY-106 UR waste cascade, for example, about 81 percent of the Al, 87 percent of the Fe, 94 percent of the Na, and 97 percent of the PO_4 precipitated in the first tank of the cascade (241-TY-105) (Colton 1995).

The sludge inventory estimates developed from the HDW model are consistent with the tank farm surveillance data for this tank (1,116 kL or 295 kgal) (Hanlon 1997). Table D3-1 compares the sample-based and HDW model estimates for chemical components, while Table D3-2 provides a similar comparison for radioactive components in tank 241-C-104.

Table D3-1. Comparison of Sample-Based and Hanford Defined Waste Model Inventory Estimates for Nonradioactive Components in Tank 241-C-104.

Analyte	Sample-Based Inventory (kg)	HDW Model-Based Inventory (kg)
Al	103,000	104,000
Bi	<4,120	2.7
Ca	<4,120	15,100
Cl	911	681
CO_3	55,000	25,900
Cr	1,660	214
F	39,400	10,500
Fe	31,400	70,300
Hg	n/r	664
K	1,520	983
La	<2,060	0
Mn	7,990	6.2
Ni	3,000	3,060
OH	n/r	30,200
NO_3	22,300	37,400
NO_2	41,600	28,900
Pb	<4,120	30,500
PO_4	5,915	1,550
Si	11,600	2,630
Na	203,000	62,300
Sr	<412	0
SO_4	<12,360	2,150
U	61,100	45,900
Zr	73,900	8,640

Table D3-2. Comparison of Sample-Based and Hanford Defined Waste Model Estimates for Radioactive Components in Tank 241-C-104 (Decayed to January 1, 1994).

Radionuclide	Sample-based inventory (Ci)	HDW model-based inventory (Ci)
^{90}Sr	6.24E+05	1.22E+06
^{137}Cs	1.23E+05	6.67E+04
$^{239/240}Pu$	5,827	1.58E+03

Note that differences of over a factor of two exist between the sample- and HDW model-based estimates for Ca, CO_3, F, Fe, Mn, Pb, PO_4, Si, Na and Zr. Among the radionuclides, appreciable differences are apparent for ^{90}Sr, ^{137}Cs, and $^{239/240}Pu$. In the next section flowsheet, fuel production, and Waste Status and Transaction Record Summary (Agnew et al. 1996) will be used to independently evaluate the credibility of the sample- and HDW model-based estimates for this waste.

D3.1 SILICON (FROM PUREX PROCESS AL-CLAD COATING WASTE)

A spreadsheet analysis of the PUREX process fuel fabrication and production records and waste transaction records (Agnew et al. 1996) shows that 7,544.4 metric tons uranium (MTU) of (aluminum-clad) PUREX process coating waste were transferred to tank 241-C-104 from 1956 to 1972. The number of MTU was computed by allocating the amount of fuel for each quarter based on the ratio of PUREX process coating waste sent to tank 241-C-104 divided by the total volume of coating waste transferred to all of the tank for that quarter. The aluminum alloy jacket around the fuel typically contains 0.046 kg Si/MTU, while the Al-Si braze metal used in the bonding layer adds another 1.269 kg Si/MTU (Kupfer et al. 1997). About 9.92 metric tons of Si should be in the PUREX process coating waste (or CWP1 and CWP2 layers) in this tank.

According to the PUREX process flowsheet (Crawley and Harmon 1960), 8.80 metric tons (MT) of Si were added to this tank based on 0.07 gram-moles/L of Si in the concentrated coating waste (171.9 gal/MTU) and correcting for the amount of dilution water in this waste (which increases the total volume to 727 gal/MTU) (18,993,000 L x 0.07 gram-moles x 171.9/727 x 28 g/gram-mole x 1/1,000,000 = 8.8 MT). This calculation is based on the total volume of coating waste and not on the number of MTU of such waste. The Si estimate that was developed from the fuel composition data (9.92 MT) appears to be only 17 percent lower than the sample derived estimate of 11.6 MT. Thus, the sample-based estimate for Si is more reasonable than the HDW-based estimate (2.63 MT).

D3.2 ALUMINUM AND NICKEL (FROM PUREX PROCESS AL-CLAD COATING WASTE)

Other components were also introduced with the PUREX process coating waste, including 365.9 MT of Al and 2.84 MT of Ni (47.1 kg of Al and 0.47 kg of Ni per MTU (Kupfer et al. 1997). Aluminum-clad fuels produced after 1959 contained about 1 percent Ni in the Al alloy jacket (Kupfer et al. 1997). The Ni inventory estimate is based on the 80 percent fraction of PUREX process coating waste transferred to tank 241-C-104 after 1959 (Agnew et al. 1996).

Most of the Al was dissolved as sodium aluminate and transferred with the supernatant to other tanks. The aluminum estimate also includes the aluminum nitrate nanohydrate added to complex fluoride ion in the zirconium coating waste (15.1 kg of Al/MTU of zirconium-clad fuel or 10.6 MT of Al). The current inventory can be estimated not only from samples, but also from the measured inventory of aluminum in tank 241-C-105 (also a PUREX process coating waste receiver) (Kupfer et al. 1997). Based on this comparison, about 50.2 MT of aluminum should be found in tank 241-C-104. This estimate was developed by multiplying the ratio of PUREX process coating waste added to tanks 241-C-104 and 241-C-105 (5,018 kgal and 3,151 kgal, respectively) by the amount of aluminum in tank 241-C-105 (31.5 MT).

The 1986 core and cores 162 and 165 provide estimates of 40.6, 146.54 and 58.75 MT of Al in tank 241-C-104, respectively. The results from core 162 appear to be biased because core 162 is not a full-depth core. If the aluminum results from segments 1 and 2 of core 165 are added to make core 162 a full-depth core, the revised estimate for this core is only 103 MT of Al (because Al is more dilute in the full-depth composite core as determined by averaging the contributions from all of the segments in this core). This new value, together with the previous estimates for the 1986 core and core 165, supports an average estimate of 67.45 MT of Al in tank 241-C-104. This estimate is only 34 percent higher than the common sludge layer derived estimate from tank 241-C-105 (50.2 MT) and appears to be more reasonable than the HDW derived estimate for this tank (104 MT). According to the HDW model, about 97 percent of the Al is associated with the PUREX process coating waste in this tank. Normally, one would expect the Al to be evenly distributed in the PUREX process coating waste in the bottom of the tank (bottom 155 cm or 61.2 in. of sludge based on Agnew's estimate of 632 kL (167 kgal) of CWP1 and CWP2 waste). However, almost all of the Al appears to have concentrated, by unknown processes, in the bottom 23 to 46 cm (9 to 18 in.) sludge layer represented by segments 4 and 6 of cores 162 and 165, respectively.

D3.3 ZIRCONIUM (FROM PUREX PROCESS COATING WASTE)

Another comparison of interest relates to the amount of Zr in this waste. According to the waste transaction records, there are three tanks (241-C-102, 241-C-104 and 241-S-107) that received coating wastes between 1967 and 1972. A spreadsheet analysis of the fuel records and PUREX process coating waste transfer records (Agnew et al. 1995) show that tank 241-C-104 received 932.7 MTU of coating waste. The Mark IV (0.947 percent enriched) zirconium-clad fuel contained 70.35 kg of Zr/MTU (RHO 1980). Based on these values, approximately 65.6 MT of Zr should be found in the tank 241-C-104 waste. The 1996 core samples indicate a mean value of 73.9 MT, which is only 12 percent higher than the fuel and waste transaction record derived estimate (65.6 MT) and is, by all appearances, a more representative estimate than the HDW derived value of 8.64 MT of Zr.

D3.4 MANGANESE (FROM PUREX PROCESS THORIA WASTE AND ORGANIC WASH WASTE)

During the second thorium campaign (in 1970), approximately 1,563 kL (413 kgal) of high-level thorium (TH1) waste were sent to tank 241-C-104. According to Allen, this waste contained 3.68 MT of $KMnO_4$, producing about 1.28 MT of Mn in the waste (Allen 1976). The volume of thorium waste is almost impossible to determine because common sludge layers have not been readily identified in other tanks. Approximately 19,542 kL (5,163 kgal) of PUREX process organic wash (OWW3) waste also was added to tank 241-C-104. This waste nominally contained 0.004 gram-moles of MnO_2/L (Anderson 1990).

Based on this concentration, OWW3 waste would have added another 4.29 MT of Mn, producing a total inventory of 5.57 MT. The 1986 core and cores 162 and 165 provide estimates of 4.43, 9.66 and 6.32 MT of Mn, respectively. For the three cores, the arithmetic average value is 6.8 MT, which is 22 percent higher than the flowsheet derived estimate (5.57 MT). Again, the sample-based estimate (6.8 MT) is more representative than the HDW derived estimate (0.006 MT) for Mn.

D3.5 LEAD (FROM PUREX PROCESS AL-CLAD COATING WASTE)

The sample-based Pb estimate ($<$4.12 MT) is clearly much lower than the HDW derived estimate (30.5 MT) and related estimates developed for lead dipped, Al-clad fuel (19.5 MT based on the number of MTU added to 241-C-104). The historical records show that 213 MT of Pb may have been added via the lead dip process to 82,400 MTU of Al-clad fuel produced after March 1954 (Kupfer et al. 1997). The lead residue from this process was apparently incorporated into all of the PUREX process coating wastes, some of which was transferred to tanks 241-C-104 and 241-C-105.

Based on the projected amount of lead in the intermetallic bonding layer of this fuel, large inventories of Pb should be present in the 241-C-104 and 241-C-105 coating wastes. However, multiple core samples from 241-C-105 show that very little Pb exists in this waste (0.48 MT) because most the lead is apparently soluble in caustic solution (Kupfer et al. 1997).

The Pb inventory in tank 241-C-104 can be estimated from the known inventory of Pb in tank 241-C-105 (also a PUREX process coating waste receiver). Based on this comparison, about 0.76 MT of Pb should be found in tank 241-C-104 waste. This estimate was developed by multiplying the ratio of PUREX process coating waste added to tanks 241-C-104 and 241-C-105 (5,018 kgal and 3,151 kgal, respectively) by the amount of Pb in tank 241-C-105 (0.48 MT). The 1986 core and cores 162 and 165 provide estimates of 1.1, <4.05 and <4.19 MT of Pb, respectively. The sample-based estimates are generally consistent with the common sludge layer derived estimate (0.76 MT) and appear to be much more reasonable than the HDW estimate (30.5 MT) and the fuel fabrication record estimate (19.5 MT). On this basis, the sample-based estimate for tank 241-C-104 appears to be upper bounding for Pb.

D3.6 URANIUM, PHOSPHATE AND CARBONATE (FROM $BiPO_4$ METAL WASTE)

Comparable methods can also be used to estimate the amount of U, PO_4 and CO_3 in the residual MW in tank 241-C-104. While most of the uranium appears to be associated with residual metal waste, some uranium also may have been added as carryover residue from fuel decladding operations (that is as a contaminate with PUREX process coating waste).

The uranium fraction in the coating waste can be estimated by multiplying the ratio of PUREX process coating waste added to tanks 241-C-104 and 241-C-105 (5,018 kgal and 3,151 kgal, respectively) by the measured amount of uranium in tank 241-C-105 (5.18 MT). This approach implicitly assumes that all of the uranium in tank 241-C-105 was carried over as residual waste material from the fuel decladding process (tank 241-C-105 also received a small amount of secondary metal waste, but all of this metal waste was later sluiced to the uranium recovery process). From this comparison, it appears that 8.25 MT of uranium may have entered the tank with PUREX process coating waste and the balance of 52.85 MT with the residual metal waste.

This residual metal waste apparently contains about 7.03 MT of PO_4, based on the amount of uranium in the metal waste (52.85 MT) and the amount of U and PO_4 typically found in metal waste (1.53 gram-moles of U/kg of MW and 0.51 gram-moles of PO_4/kg of MW from the analysis of 241-T-101 MW sludge in the Uranium Recovery Process Manual (GE 1951). The 1986 core and cores 162 and 165 provide tank inventory estimates of 12.9, 5.95 and 5.86 MT of PO_4, respectively. The average value based on these three cores is 8.23 MT, compared to tank 241-T-101 MW sludge derived estimate of 7.03 MT. The degree of agreement seen between these two methods supports a phosphate inventory range between 7.0 and 9.0 MT, rather than the 1.55 MT estimate of the HDW (Agnew et al. 1996).

The amount of CO_3 in the residual MW also can be estimated by these techniques. Based on the amount of uranium in the metal waste (52.85 MT), the amount of CO_3 appears to vary from 16.6 to 39.6 MT (1.53 g moles of U/kg of MW and 1.92 to 4.4 g moles of CO_3/kg of MW (GE 1951).

A considerable but indeterminate amount of CO_3 was also absorbed from the atmosphere judging from the amount of precipitated aluminum ion the surface of the sludge (lower and upper halves of segments 1 and 2 of core 165, compared to the lower half of segment 2). The metal waste based predictions for CO_3 are generally consistent with the sample-based estimate of 55 MT, but by the same token, are not inconsistent with the HDW derived estimate of 25.9 MT of CO_3.

Moreover, based on the amount of uranium in metal waste, it also appears that tank 241-C-104 contains approximately 125,400 kg of MW sludge, or 72.1 kL (19 kgal) of residual metal waste, assuming an average density of 1.74 kg/L (Agnew et al. 1996). In the HDW model, it is assumed that only 11.3 kL (3 kgal) of residual metal waste exist in this tank.

D3.7 CESIUM AND STRONTIUM

Tank 241-C-104 has an estimated heat load of 11,410 Btu/h or 3,344 watts (Kummerer 1995). This heat load corresponds to 708,500 Ci of ^{137}Cs or 499,100 Ci of ^{90}Sr, values that are in the same range as the sample-based estimates for this tank (123,000 Ci of ^{137}Cs and 624,000 Ci of ^{90}Sr, decayed to January 1, 1994).

Thermal-model-based values are equivalent to a heat load of 4,761 watts, based on a headspace temperature of 86.4 °F and waste temperature of 32 °C (89.5 °F). Because the reliability of the tank thermal model has not been independently verified for this tank, it will be assumed for purposes of the standard inventory estimate, that the sample-based estimates for ^{137}Cs and ^{90}Sr are correct. The sample-based estimates seem to be more representative than the HDW model estimates for this tank (1.22E+06 Ci of ^{90}Sr and 6.67E+04 Ci of ^{137}Cs, also decayed to January 1, 1994).

D3.8 SUMMARY

Estimates derived from flowsheets, fuel, and waste transaction records and common sludge layers in other tanks appear to be consistent with, and in most cases in good agreement with sample-based estimates for Al, Mn, Ni, Pb, PO_4, and Zr. While projected values for CO_3 are highly variable, these estimates too are generally consistent with the values derived from the three core samples of this tank. Based on the indicated comparison, it appears that the flowsheet and common sludge layer derived estimates support the credibility of the sample-based estimates for this tank. Moreover, this analysis also shows that the HDW estimates for Si, Mn, PO_4 and Zr are clearly low, and comparable estimates for Al and Pb high with respect to the sample-based inventories in tank 241-C-104 (Table D3-1). Sample-based estimates for ^{137}Cs and ^{90}Sr are generally consistent with the thermal modelling results for this tank, although the analytical values are somewhat higher than the concentrations that might be expected from the thermal model.

Based on this comparison, the 1986 core and two 1996 cores appear to offer the most reasonable and consistent set of estimates currently available for this tank. These samples will be used to develop the best-basis inventory for tank 241-C-104 because these samples were taken from different risers, the results were statistically analyzed for the 1996 cores, and in many cases replicate analyses were performed to verify the accuracy of the results.

D4.0 DEFINE THE BEST-BASIS AND ESTABLISH COMPONENT INVENTORIES

Chemical and radionuclide inventory estimates are generally derived from one of three sources of information: 1) sample analysis and sample derived inventory estimates, 2) component inventories predicted by the HDW model based on process knowledge and historical tank transfer information, or 3) a tank-specific process estimate based on process flowsheets, reactor fuel data, essential materials records, or comparable sludge layers and sample information from other tanks.

An effort is currently underway to provide waste inventory estimates that will serve as the standard characterization data for various waste management activities. As part of this effort, a survey and analysis of various sources of information relating to the chemical and radionuclide component inventories in tank 241-C-104 was performed, including the following:

1. Data from three core samples taken in 1986 and 1996 (Weiss and Schull 1988, and the statistical analysis results from the 1996 sampling event for this tank, Appendix B of the TCR).

2. Component inventory estimates provided by the HDW model (Agnew et al. 1996).

3. Evaluation of CWP1 and CWP2 wastes based on the fuel and waste transaction records and fuel fabrication records.

4. Analysis of CWP1/CWP2 sludge based on common sludge layers in tank 241-C-105 and the waste transaction records for tanks 241-C-104 and 241-C-105.

5. Analysis of the PUREX process flowsheet (Crawley and Harmon 1960), thorium campaign records and the composition of OWW3 waste, together with the waste transaction records for tank 241-C-104.

6. Analysis of residual metal waste based on the composition of tank 241-T-101 MW (GE 1951).

7. Evaluation of the estimated thermal loads provided by the sample-based inventories of ^{90}Sr and ^{137}Cs relative to thermal modelling results for this tank.

Based on this analysis, a best-basis inventory was developed. The 1996 cores (and for Al, Mn and PO_4, average values for the 1986 core and two 1996 cores) were used to generate estimates for the chemical and radionuclide components in this waste. The waste in tank 241-C-104 primarily consists of PUREX process coating (CWP1 and CWP2) waste, CWP/Zr waste, $BiPO_4$ MW, PUREX process organic wash (OWW3) waste, PUREX process TH waste, PUREX process high-level (P2) waste, with small amounts of various other wastes..

The best-basis inventory for tank 241-C-104 is presented in Tables D4-1 and D4-2. A high level of confidence is assigned to the component inventory estimates for Al, Mn, Ni, Si, and Zr because of reasonable agreement between sample-based estimates and flowsheet derived estimates for these components. For all other components a medium level of confidence is assigned to the sample-based estimates, principally because of the "less than" values assigned by the statisticians, which indicates that a majority of the observations were below the detection level.

Table D4-1. Best-Basis Inventory Estimates for Nonradioactive Components in Tank 241-C-104 (January 31, 1997). (2 sheets)

Analyte	Total Inventory (kg)	Basis (S, M, or E)[1]	Comment
Al	67,450	E	Weiss and Schull (1988), Appendix B
Bi	<4,120	S	
Ca	<4,120	S	
Cl	911	S	
CO_3	55,000	S	
Cr	1,660	S	
F	39,400	S	
Fe	31,400	S	
Hg	664	M	Agnew et al. (1996)

Table D4-1. Best-Basis Inventory Estimates for Nonradioactive Components in Tank 241-C-104 (January 31, 1997). (2 sheets)

Analyte	Total Inventory (kg)	Basis (S, M, or E)[1]	Comment
K	<1,960	S	
La	<2,060	S	
Mn	6,800	S	
Na	203,000	S	
Ni	3,000	S	
NO_2	41,600	S	
NO_3	22,300	S	
OH	n/r		
Pb	<4,120	S	
P as PO_4	8,230	S	
Si	11,600	S	
S as SO_4	<12,360	S	
Sr	<412	S	
TOC	16,100	S	
U_{TOTAL}	61,100	S	
Zr	73,900	S	

Notes:

[1]S = Sample-based
M = Hanford defined waste model-based
E = Engineering assessment-based

Table D4-2. Best-Basis Inventory Estimates for Radioactive Components in Tank 241-C-104 (Decayed to January 1, 1994) (2 Sheets)

Analyte	Total Inventory (Ci)	Basis (S, M, or E)[1]	Comment
^{3}H	n/r		
^{14}C	0.84	S	Weiss and Schull (1988)
^{59}Ni	n/r		
^{60}Co	610	S	Appendix B
^{63}Ni	n/r		
^{79}Se	n/r		
^{90}Sr	624,000	S	Appendix B
^{90}Y	624,000	E	Based on ^{90}Sr
^{93}Zr	n/r		
^{93m}Nb	n/r		
^{99}Tc	3,740	S	Weiss and Schull (1988)
^{106}Ru	n/r		
^{113m}Cd	n/r		
^{125}Sb	n/r		
^{126}Sn	n/r		
^{129}I	n/r		
^{134}Cs	n/r		
^{137}Cs	123,000	S	Appendix B
^{137m}Ba	116,000	E	Based on ^{137}Cs
^{151}Sm	n/r		
^{152}Eu	n/r		
^{154}Eu	1,880	S	Appendix B
^{155}Eu	<1,850	S	Appendix B
^{226}Ra	n/r		
^{227}Ac	n/r		
^{228}Ra	n/r		
^{229}Th	n/r		
^{231}Pa	n/r		
^{232}Th	n/r		

Table D4-2. Best-Basis Inventory Estimates for Radioactive Components in Tank 241-C-104 (Decayed to January 1, 1994) (2 Sheets)

Analyte	Total Inventory (Ci)	Basis (S, M, or E)[1]	Comment
^{232}U	n/r		
^{233}U	n/r		
^{234}U	n/r		
^{235}U	n/r		
^{236}U	n/r		
^{237}Np	n/r		
^{238}Pu	n/r		
^{238}U	n/r		
$^{239/240}Pu$	5,827	S	Appendix B
^{241}Am	7,150	S	Appendix B
^{241}Pu	n/r		
^{242}Cm	n/r		
^{242}Pu	n/r		
^{243}Am	n/r		
^{243}Cm	n/r		
^{244}Cm	n/r		

Notes:

[1]S = Sample-based
M = Hanford defined waste model-based
E = Engineering assessment-based

D5.0 APPENDIX D REFERENCES

Agnew, S. F., J. Boyer, R. A. Corbin, T. B. Duran, J. R. Fitzpatrick, K. A. Jurgensen, T. P. Ortiz, and B. L. Young, 1996, *Hanford Tank Chemical and Radionuclide Inventories: HDW Model Rev. 3*, LA-UR-96-858, Los Alamos National Laboratory, Los Alamos, New Mexico.

Allen, G. K., 1976, *Estimated Inventory of Chemicals Added to Underground Waste Tanks, 1944-1975*, ARH-CD-601B, Rev. 0, Atlantic Richfield Hanford Company, Richland, Washington.

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Swaney, S. L., 1993, *Waste Level Discrepancies between Manual Readings and Current Waste Inventory for Single-Shell Tanks*, (internal memorandum 7C242-93-038 to G. T. Frater, December 10), Westinghouse Hanford Company, Richland, Washington.

Weiss, R. L., and K. E. Schull, 1988, *Data Transmittal Package for 241-C-104 Waste Tank Characterization*, SD-RE-TI-199, Rev. 0, Rockwell Hanford Operations, Richland, Washington.

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APPENDIX E

BIBLIOGRAPHY FOR TANK 241-C-104

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APPENDIX E

BIBLIOGRAPHY FOR TANK 241-C-104

Appendix E provides a bibliography of information that supports the characterization of tank 241-C-104. This bibliography represents an in-depth literature search of all known information sources that provide sampling, analysis, surveillance, and modeling information, as well as processing occurrences associated with tank 241-C-104 and its respective waste types.

The references in this bibliography are separated into three broad categories containing references broken down into subgroups. These categories and their subgroups are listed below.

I. NON-ANALYTICAL DATA

- Ia. Models/Waste Type Inventories/Campaign Information
- Ib. Fill History/Waste Transfer Records
- Ic. Surveillance/Tank Configuration
- Id. Sample Planning/Tank Prioritization
- Ie. Data Quality Objectives/Customers of Characterization Data

II. ANALYTICAL DATA - SAMPLING OF TANK WASTE AND WASTE TYPES

- IIa. Sampling of tank 241-C-104
- IIb. Sampling of 242-A saltcake waste type

III. COMBINED ANALYTICAL/NON-ANALYTICAL DATA

- IIIa. Inventories using both Campaign and Analytical Information
- IIIb. Compendium of Existing Physical and Chemical Documented Data Sources

This bibliography is broken down into the appropriate sections of material to use, with an annotation at the end of each reference, or set of references, describing the information source. Where possible, a reference is provided for information sources. A majority of the information listed below may be found in the Lockheed Martin Hanford Corporation Tank Characterization Resource Center.

I. NON-ANALYTICAL DATA

Ia. Models/Waste Type Inventories/Campaign Information

Anderson, J. D., 1990, *A History of the 200 Area Tank Farms*, WHC-MR-0132, Westinghouse Hanford Company, Richland, Washington.

- Document contains single-shell tank fill history and primary campaign/waste type information up to 1981.

Boldt, A. L., *Redox Chemical Flowsheet HW No. 9*, ISO-335, 1966, Isochem, Inc., Richland, Washington.

- Document contains compositions of material balance for REDOX process as well as a separations plan denoting process stream waste before transfer to 200 Area waste tanks.

Hess, A. L., and P. C. Doto, 1991, *Review of Records for Source of ^{233}U in Tank 104-C*, (internal memorandum 29210-91-030 to S. D. Godfrey, August 19), Westinghouse Hanford Company, Richland, Washington.

- Document contains estimated ^{233}U inventory based on process records.

Jungfleisch, F. M., and B. C. Simpson, 1993, *Preliminary Estimation of the Waste Inventories in Hanford Tanks Through 1980*, WHC-SD-WM-TI-057, Rev. 0A, Westinghouse Hanford Company, Richland, Washington.

- Document describes a model for estimating tank waste inventories using process knowledge, radioactive decay estimates using ORIGEN, and assumptions about waste types, solubility, and constraints.

Schneider, K. J., 1951, *Flowsheets and Flow Diagrams of Precipitation Separations Process*, HW- 23043, Hanford Atomic Products Operation, Richland, Washington.

- Document contains compositions of process stream waste before transfer to 200 Area waste tanks.

Ib. Fill History/Waste Transfer Records

Agnew, S. F., P. Baca, R. A. Corbin, T. B. Duran, and K. A. Jurgensen, 1996, *Waste Status and Transaction Record Summary for the Northeast Quadrant of the Hanford 200 Area*, WHC-SD-WM-TI-615, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

- Document contains spreadsheets depicting all known tank additions/transfers.

Anderson, J. D., 1990, *A History of the 200 Area Tank Farms*, WHC-MR-0132, Westinghouse Hanford Company, Richland, Washington.

- Document contains tank fill histories and primary campaign/waste type information up to 1981.

Ic. Surveillance/Tank Configuration

Alstad, A. T., 1993, *Riser Configuration Document for Single-Shell Waste Tanks*, WHC-SD-WM-TI-553, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

- Document shows riser location in relation to tank aerial view as well as a description of each riser and its contents.

Lipnicki, J., 1996, *Waste Tank Risers Available for Sampling*, WHC-SD-WM-TI-710, Rev. 3, Westinghouse Hanford Company, Richland, Washington.

- Document gives an assessment of riser locations for each tank; however, not all tanks are included/completed. Also included is an estimate of the risers available for sampling.

Tran, T. T., 1993, *Thermocouple Status Single-Shell & Double-Shell Waste Tanks*, WHC-SD-WM-TI-553, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

- Document provides thermocouple location and status information for double- and single-shell tanks.

Welty, R. K., 1988, *Waste Storage Tank Status and Leak Detection Criteria*, WHC-SD-WM-TI-356, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

- Document provides leak detection information for all single- and double-shell tanks. Liquid level, liquid observation well, and dry well readings are included.

Id. Sample Planning/Tank Prioritization

Brown, T. M., T. J. Kunthara, S. J. Eberlein, and J. W. Hunt, 1996, *Tank Waste Characterization Basis*, WHC-SD-WM-TA-164, Rev. 2, Westinghouse Hanford Company, Richland, Washington.

- Document establishes an approach to determine the priority for tank sampling and characterization and identifies high priority tanks for sampling.

Homi, C. S., 1996, *Tank 241-C-104 Push Mode Core Sampling and Analysis Plan*, WHC-SD-WM-TSAP-102, Rev. 0A, Westinghouse Hanford Company, Richland, Washington.

- Document contains detailed sampling and analysis scheme for core samples to be taken from tank 241-C-104 to address applicable DQOs.

Mulkey, C. H., 1996, *Single-Shell Tank System Waste Analysis Plan*, WHC-EP-0356, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

- Document is the waste analysis plan for single-shell tanks as required by WAC-173-303 and 40 CFR Part 265.

Stanton, G. A., 1996, *Baseline Sampling Schedule, Change 96-04*, (internal letter 75610-96-11 to distribution, August 22), Westinghouse Hanford Company, Richland, Washington.

- Letter provides a tank waste sampling schedule through fiscal year 2002 and lists samples taken since 1994.

Winkelman, W. D., 1996, *Tank 241-C-104 Tank Characterization Plan*, WHC-SD-WM-TP-208, Rev. 3, Westinghouse Hanford Company, Richland, Washington.

- Document discusses all relevant DQOs and how their requirements will be met for tank 241-C-104.

Winkelman, W. D., J. W. Hunt, and L. J. Fergestrom, 1996, *Fiscal Year 1997 Tank Waste Analysis Plan*, WHC-SD-WM-PLN-120, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

- Document contains *Hanford Federal Facility Agreement and Consent Order* requirement driven TWRS characterization program information and a list of tanks addressed in fiscal year 1997.

Ie. Data Quality Objectives/Customers of Characterization Data

Dukelow, G. T., J. W. Hunt, H. Babad, and J. E. Meacham, 1995, *Tank Safety Screening Data Quality Objective*, WHC-SD-WM-SP-004, Rev. 2, Westinghouse Hanford Company, Richland, Washington.

- DQO used to determine if tanks are under safe operating conditions.

Friar, D. E., and T. S. Vail, 1996, *Quest for Consensus: Hanford Waste Tanks and the Criticality Safety Issue*, WHC-SA-3100-S, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

- DQO used to determine if tanks are under safe operating conditions.

Godfrey, S. D., 1991, *Tank 104-C Investigation Team Report*, (internal memorandum 76400-91-023 to H. D. Harmon, July 15), Westinghouse Hanford Company, Richland, Washington.

- Memorandum uses sample data to inventory plutonium content in tank.

Marchetti, S., 1991, *Response to DOE-HQ Questions Regarding Unusual Occurrence Report RL-WHC-TANKFARM-1991-1021, "Tank 241-C-104 Core Sample Exceeded Criticality Specifications"*, (letter 9155190 to R. E. Gerton, U.S. Department of Energy, July 30), Westinghouse Hanford Company, Richland, Washington.

- Memorandum uses sample data to respond to Unusual Occurrence Report.

Osborne, J. W., J. L. Huckaby, E. R. Hewitt, C. M. Anderson, D. D. Mahlum, B. A. Pulsipher, and J. Y. Young, 1994, *Data Quality Objectives for Generic In-Tank Health and Safety Vapor Issue Resolution*, WHC-SD-WM-DQO-002, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

- DQO used to determine if tank headspaces contain potentially flammable levels of gases and vapors and or if there is a potential for worker hazards associated with the toxicity of constituents in any vapor emissions from the tanks.

Simpson, B. C., and D. J. McCain, 1996, *Historical Model Evaluation Data Requirements*, WHC-SD-WM-DQO-018, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

- Document identifies analytical parameters to characterize waste into one of five waste types.

Turner, D. A., H. Babad, L. L. Buckley, and J. E. Meacham, 1995, *Data Quality Objective to Support Resolution of the Organic Complexant Safety Issue*, WHC-SD-WM-DQO-006, Rev. 2, Westinghouse Hanford Company, Richland, Washington.

- DQO used to categorize organic tanks as "safe," "conditionally safe," or "unsafe" based on fuel and moisture concentrations and to support resolution of the safety issue.

II. ANALYTICAL DATA - SAMPLING OF TANK WASTE AND WASTE TYPES

IIa. Sampling of Tank 241-C-104

Buckingham, J. S., 1972, *Uranium and Plutonium Analysis of TK-104-C and Solubility of Uranium in Synthetic Thorium Waste*, (internal memorandum to D. J. Larkin, September 11), Atlantic Richfield Hanford Company, Richland, Washington.

- Memorandum contains historical analytical results for tank 241-C-104.

Fowler, K. D., 1991, *Tank Plutonium Inventory Estimates*, (internal memorandum 72100-91-049 to S. D. Godfrey, June 28), Westinghouse Hanford Company, Richland, Washington.

- Memorandum contains plutonium inventory information for some C-Farm tanks.

Fritts, L. L., 1997, *Tank 241-C-104, Cores 162 and 165 Analytical Results for the Final Report*, WHC-SD-WM-DP-211, Rev. 1, Rust Federal Services of Hanford, Incorporated, Richland, Washington.

- Document contains analytical results from July 1996 push mode core sampling event.

Huckaby, J. W., and D. R. Bratzel, 1995, *Tank 241-C-104 Vapor Sampling and Analysis Tank Characterization Report*, WHC-SD-WM-ER-442, Rev. 1A, Westinghouse Hanford Company, Richland, Washington.

- Document contains vapor sampling analytical results from March 1994.

Lucke, R. B., B. D. McVeety, T. W. Clauss, K. H. Pool, J. S. Young, M. McCulloch, M. W. Ligotke, J. S. Fruchter, and S. C. Goheen, 1995, *Vapor Space Characterization of Waste Tank 241-C-104: Results from Samples Collected on 2/17/94 and 3/3/94*, PNL-10499, Pacific Northwest Laboratory, Richland, Washington.

- Document contains vapor sampling analytical results from February and March 1994.

Starr, J. L., 1977, *241-104-C Sample #9172*, (internal memorandum to J. W. Bailey, December 15), Rockwell Hanford Operations, Richland, Washington.

- Memorandum contains historical analytical results for tank 241-C-104.

Wheeler, R. E., 1976, *Analysis of Tank Farm Sample, Sample No.: T-3267, Tank: 104-C, Received: March 15, 1976*, (internal memorandum to R. L. Walser, August 7), Atlantic Richfield Hanford Company, Richland, Washington.

- Memorandum contains historical analytical results for tank 241-C-104.

Ulbricht, W. H., 1988, *Preliminary Assay Data of Gases from the 241-C-104 Tank*, (internal memorandum 12221-ASL88-220 to K. G. Carothers, August 31), Westinghouse Hanford Company, Richland, Washington.

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Vail, T. S., 1986, *C-Farm Core Sampling Recoverability*, (internal memorandum to J. C. Bergam, D. W. Lindsey, F. E. Boyd, K. W. Owens, S. J. Joncus, and W. H. Trott, September 23), Rockwell Hanford Operations, Richland, Washington.

- Memorandum contains core segment sampling data.

Wheeler, R. E., 1974, *Analysis of Tank Farm Samples, Sample: T-3621, 104-C*, (internal memorandum to R. L. Walser, May 13), Atlantic Richfield Hanford Company, Richland, Washington.

- Memorandum contains historical analytical results for tank 241-C-104.

Wheeler, R. E., 1974, *Analysis of Tank Farm Samples, Sample: T-4511, 104-C*, (internal memorandum to R. L. Walser, May 23), Atlantic Richfield Hanford Company, Richland, Washington.

- Memorandum contains historical analytical results for tank 241-C-104.

Wheeler, R. E., 1974, *Analysis of Tank Farm Samples, Sample: T-5312, 104-C*, (internal memorandum to R. L. Walser, November 19), Atlantic Richfield Hanford Company, Richland, Washington.

- Memorandum contains historical analytical results for tank 241-C-104.

Wheeler, R. E., 1975, *Analysis of Tank Farm Samples, Sample: T-8583, Tank 104-C, Received: October 6, 1975*, (internal memorandum to R. L. Walser, December 15), Atlantic Richfield Hanford Company, Richland, Washington.

- Memorandum contains historical analytical results for tank 241-C-104.

Wheeler, R. E., 1976, *Analysis of Tank Farm Samples, Sample: T-225, Tank 104-C, Received: December 1, 1975*, (internal memorandum to R. L. Walser, February 12), Atlantic Richfield Hanford Company, Richland, Washington.

- Memorandum contains historical analytical results for tank 241-C-104.

Wheeler, R. E., 1976, *Analysis of Tank Farm Samples, Sample: T-9511, Tank: 104-C, Received: November 5, 1975*, (internal memorandum to R. L. Walser, February 12), Atlantic Richfield Hanford Company, Richland, Washington.

- Memorandum contains historical analytical results for tank 241-C-104.

Wheeler, R. E., 1976, *Analysis of Tank Farm Samples, Sample: T-374, Tank 104-C, Received: December 5, 1975*, (internal memorandum to R. L. Walser, February 13), Atlantic Richfield Hanford Company, Richland, Washington.

- Memorandum contains historical analytical results for tank 241-C-104.

Wheeler, R. E., 1976, *Analysis of Tank Farm Samples, Sample: T-769, Tank 104-C, Received: December 18, 1975*, (internal memorandum to R. L. Walser, February 13), Atlantic Richfield Hanford Company, Richland, Washington.

- Memorandum contains historical analytical results for tank 241-C-104.

Wheeler, R. E., 1976, *Analysis of Tank Farm Samples, Sample No.: T-1142, Tank: 104-C, Received: January 1976*, (internal memorandum to R. L. Walser, March 2), Atlantic Richfield Hanford Company, Richland, Washington.

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Wheeler, R. E., 1976, *Analysis of Tank Farm Samples, Sample No.: T-2549, Tank: 104-C, Received: February 19, 1976*, (internal memorandum to R. L. Walser, March 29), Atlantic Richfield Hanford Company, Richland, Washington.

- Memorandum contains historical analytical results for tank 241-C-104.

Wheeler, R. E., 1976, *Analysis of Tank Farm Sample, Sample No.: T-2603, Tank: 104-C, Received: February 20, 1976*, (internal memorandum to R. L. Walser, August 13), Atlantic Richfield Hanford Company, Richland, Washington.

- Memorandum contains historical analytical results for tank 241-C-104.

Weiss, R. L., 1987, *Reanalysis of Tank 241-C-104 Sample for Technetium*, (internal memorandum 65453-87-005 to W. W. Schulz, January 15), Rockwell Hanford Operations, Richland, Washington.

- Memorandum contains historical analytical results specific to technetium for tank 241-C-104.

Weiss, R. L., 1987, *Recalculation of Plutonium and Uranium Concentrations for Tanks 241-C-103, 104, 105, and 106 from 1986 Core sampling Data*, (internal memorandum 28600-91-079 to S. D. Godfrey, July 8), Westinghouse Hanford Company, Richland, Washington.

- Document contains corrections to historical core sampling analytical results for C Farm tanks.

Weiss, R. L., and K. E. Schull, 1991, *Data Transmittal Package for 241-C-104 Waste Tank Characterization*, WHC-SD-RE-TI-199, Rev. 0A, Westinghouse Hanford Company, Richland, Washington.

- Document contains historical analytical results from April 1986 core sampling event.

IIb. Sampling of 242-A Saltcake Waste Type

Bratzel, D. R., 1981, *Analysis of Routine Evaporator Samples*, (internal memorandum 65453-81-339 to W. H. Sant, October 30), Rockwell Hanford Operations, Richland, Washington.

- Memorandum contains nominal TOC concentration and specific gravity of 242-A evaporator samples.

Carothers, K. G., 1991, *Peer Review of Recommended 242-A Evaporator SAR Source Term*, (internal memorandum 76400-91-044 to R. B. Gelman, August 16), Westinghouse Hanford Company, Richland, Washington.

- Memorandum contains maximum estimations of evaporator feed analyte concentrations for various tank farms.

III. COMBINED ANALYTICAL/NON-ANALYTICAL DATA

IIIa. Inventories using both Campaign and Analytical Information

Agnew, S. F., R. A. Corbin, J. Boyer, T. B. Duran, K. A. Jurgensen, T. P. Ortiz, B. L. Young, R. Anema, and C. Ungerecht, 1996, *History of Organic Carbon in Hanford HLW Tanks: HDW Model Rev. 3*, LA-UR-96-989, Los Alamos National Laboratory, Los Alamos, New Mexico.

- Document attempts to account for the disposition of soluble organics and provides estimates of TOC content for each tank.

Agnew, S. F., J. Boyer, R. A. Corbin, T. B. Duran, J. R. Fitzpatrick, K. A. Jurgensen, T. P. Ortiz, and B. L. Young, 1997, *Hanford Tank Chemical and Radionuclide Inventories: HDW Rev. 4*, LA-UR-96-3860, Los Alamos National Laboratory, Los Alamos, New Mexico.

- Document contains waste type summaries, primary chemical compound/analyte and radionuclide estimates for sludge, supernatant, and solids, as well as SMM, TLM, and individual tank inventory estimates.

Allen, G. K., 1975, *Hanford Liquid Waste Inventory as of September 30, 1974*, ARH-CD-229, Rev. 0, Atlantic Richfield Company, Richland, Washington.

- Document contains major components for waste types and some assumptions.

Allen, G. K., 1976, *Estimated Inventory of Chemicals Added to Underground Waste Tanks, 1944 - 1975*, ARH-CD-601B, Rev. 0, Atlantic Richfield Hanford Company, Richland, Washington.

- Document contains major components for waste types and some assumptions. Purchase records are used to estimate chemical inventories.

Brevick, C. H., R. L. Newell, and J. W. Funk, 1996, *Historical Tank Content Estimate for the Northeast Quadrant of the Hanford 200 East Area*, WHC-SD-WM-ER-349, Rev. 1A, Westinghouse Hanford Company, Richland, Washington.

- Document contains summary information for tanks in B, BX, and BY Tank Farms as well as in-tank photo collages and inventory estimates.

Geier, R. G., 1976, *Estimated Hanford Liquid Wastes Chemical Inventory as of June 30, 1976*, ARH-CD-768, Rev. 0, Atlantic Richfield Hanford Company, Richland, Washington.

- Document contains nominal concentrations of various analytes for the liquid waste in some of the waste tanks.

Klem, M. J., 1988, *Inventory of Chemicals Used at Hanford Production Plants and Support Operations (1944 - 1980)*, WHC-EP-0172, Westinghouse Hanford Company, Richland, Washington.

- Document provides a list of chemicals used in production facilities and support operations that sent wastes to the single-shell tanks. List is based on chemical process flowsheets, essential materials consumption records, letters, reports, and other historical data.

Kupfer, M. J., 1996, *Interim Report: Best Basis Total Chemical and Radionuclide Inventories in Hanford Site Tank Waste*, WHC-SD-WM-TI-740, Rev. B-Draft, Westinghouse Hanford Company, Richland, Washington.

- Document contains a global component inventory for 200 Area waste tanks, currently inventoried are 14 chemical and 2 radionuclide components.

Schmittroth, F. A., 1995, *Inventories for Low-Level Tank Waste*, WHC-SD-WM-RPT-164, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

- Document contains a global inventory based on process knowledge and radioactive decay estimations using ORIGEN2. Pu and U waste contributions are taken at 1% of the amount used in processes. Also compares information on Tc-99 from both ORIGEN2 and analytical data.

IIIb. Compendium of Existing Physical and Chemical Documented Data Sources

Agnew, S. F., and J. G. Watkin, 1994, *Estimation of Limiting Solubilities for Ionic Species in Hanford Waste Tank Supernatants*, LA-UR-94-3590, Los Alamos National Laboratory, Los Alamos, New Mexico.

- Document gives solubility ranges used for key chemical and radionuclide components based on supernatant sample analyses.

Brevick, C. H., J. L. Stroup, and J. W. Funk, 1997, *Supporting Document for the Northeast Quadrant Historical Tank Content Estimate for C Tank Farm*, WHC-SD-WM-ER-313, Rev. 1B, Fluor Daniel Northwest, Inc., Richland, Washington.

- Document contains summary information for tanks in the C Tank Farm as well as appendices containing more detailed information including tank waste level history, tank temperature history, cascade and dry well charts, riser information, in-tank photo collages, and tank layer model bar chart and spreadsheet.

Brevick, C. H., L. A. Gaddis, and E. D. Johnson, 1996, *Tank Waste Source Term Inventory Validation, Vol I, II, and III*, WHC-SD-WM-ER-400, Rev. 0A, Westinghouse Hanford Company, Richland, Washington.

- Document contains a quick reference to sampling information in spreadsheet or graphical form for 24 chemicals and 11 radionuclides for all the tanks.

Clark, R. G., 1986, *I-129 Analytical Data*, (internal memorandum 65452-86-100 to R. L. Weiss, July 14), Rockwell Hanford Operations, Richland, Washington.

- Memorandum contains I-129 analysis results for a select number of tanks.

Hanlon, B. M., 1997, *Waste Tank Summary Report for Month Ending December 31, 1996*, WHC-EP-0182-105, Westinghouse Hanford Company, Richland, Washington.

- This document, updated monthly, contains a summary of: tank waste volumes, Watch List tanks, occurrences, tank integrity information, equipment readings, tank location, leak volumes, and other miscellaneous tank information.

Hill, J. G., G. S. Anderson, and B. C. Simpson, 1995, *The Sort on Radioactive Waste Type Model: A Method to Sort Single-Shell Tanks into Characteristic Groups*, PNL-9814, Rev. 2, Pacific Northwest Laboratory, Richland, Washington.

- Document describes a system of sorting single-shell tanks into groups based on the major waste types contained in each tank.

Husa, E. I., 1993, *Hanford Site Waste Storage Tank Information Notebook*, WHC-EP-0625, Westinghouse Hanford Company, Richland, Washington.

- Document contains in-tank photos and summaries of the tank description, leak detection system, and tank status.

Husa, E. I., 1995, *Hanford Waste Tank Preliminary Dryness Evaluation*, WHC-SD-WM-TI-703, Rev. 0, Westinghouse Hanford Company, Richland, Washington.

- Document gives an assessment of the relative dryness of tank wastes.

Klem, M. J., 1990, *Total Organic Carbon Concentration of Single Shell Tank Waste*, (internal memorandum 82316-90-032 to R. E. Raymond, April 27), Westinghouse Hanford Company, Richland, Washington.

- Memorandum gives a summary of TOC information from laboratory analysis for single shell tanks.

Shelton, L. W., 1996, *Chemical and Radionuclide Inventory for Single and Double Shell Tanks*, (internal memorandum 74A20-96-30 to D. J. Washenfelder, February 28), Westinghouse Hanford Company, Richland, Washington.

- Memorandum contains a tank inventory estimate based on analytical information.

Shelton, L. W., 1995a, *Chemical and Radionuclide Inventory for Single and Double Shell tanks*, (internal memorandum 75520-95-007 to R. M. Orme, August 8), Westinghouse Hanford Company, Richland, Washington.

- Memorandum contains a tank inventory estimate based on analytical information.

Shelton, L. W., 1995b, *Radionuclide Inventories for Single and Double Shell Tanks*, (internal memorandum 71320-95-002 to F. M. Cooney, February 14), Westinghouse Hanford Company, Richland, Washington.

- Memorandum contains a tank inventory estimate based on analytical information.

Toth, J. J., C. E. Willingham, P. G. Heasler, and P.D. Whitney, 1994, *Organic Carbon in Hanford Single-Shell Tank Waste*, PNL-9434, Pacific Northwest Laboratory, Richland, Washington.

- Document contains organic carbon analytical results and model estimates for tanks.

Van Vleet, R. J., 1993, *Radionuclide and Chemical Inventories for the Single Shell Tanks*, WHC-SD-WM-TI-565, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

- Document contains selected sample analysis tables prior to 1993 for single shell tanks.

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DISTRIBUTION SHEET

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R. J. Cash	S7-14	X			
W. L. Cowley	R2-54	X			
G. L. Dunford	A2-34	X			
G. D. Johnson	S7-14	X			
J. E. Meacham	S7-14	X			
Fluor Daniel Northwest					
J. L. Stroup	S3-09	X			
Lockheed Martin Hanford, Corp.					
J. H. Baldwin	R2-12	X			
K. M. Hodgson	H0-34	X			
T. J. Kelley	S7-21	X			
L. M. Sasaki	R2-12	X			
B. C. Simpson	R2-12	X			
L. R. Webb	R2-12	X			
ERC (Environmental Resource Center)	R1-51	X			
T.C.S.R.C.	R1-08	5			
Lockheed Martin Services, Inc.					
B. G. Lauzon	R1-08	X			
Central Files	A3-88	X			
EDMC	H6-08	X			
Numatec Hanford Corporation					
J. S. Garfield	H5-49	X			
J. S. Hertzel	H5-61	X			
D. L. Lamberd	H5-61	X			
Pacific Northwest National Laboratory					
A. F. Noonan	K9-91	X			
Rust Federal Services of Hanford, Inc.					
C. T. Narquis	T6-16	X			